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LANGUAGE DEVELOPMENT AND ITS RELATIONSHIP TO THEORY OF MIND IN CHILDREN WITH HIGH-FUNCTIONING AUTISM

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"These children often show a surprising sensitivity to the personality of the teacher, they can be taught, but only by those who give them true understanding and affection, people who show kindness towards them and, yes, humour ..."

Hans Asperger, 1944

For my sons, Adam and Josh
And in loving memory of my uncle, Dr Alwyn C. Scott

Declaration

In this thesis, the data from Time point 1 is from a study entitled "Prosodic Ability in Children with Autism" which was completed in 2004 at Queen Margaret University College, funded by the Chief Scientist Office of the Scottish Executive. Publications reporting this project are: Peppé and McCann (2003); McCann and Peppé (2003); Gibbon et al. (2004); Peppé et al. (in press); McCann et al. (2006) and McCann et al. (in press). Details of the CSO study were shared with this author for the current study reported here.

I confirm that the Time point 2 data reported in this thesis is my own work and that appropriate credit has been given where reference has been made to the work of others.

Lianne Carroll
14 February, 2007

Abstract

Impairments in language, prosodic and theory of mind (ToM) ability in individuals with high-functioning autism (HFA) have been widely reported. However, this PhD study is the first to investigate changes in receptive and expressive prosody skills over time. This is also the first study to report on the relationship between prosody and ToM, independent of language ability. Additionally, this study presents a new adaptation of a ToM assessment, on which prosodic and verbal input are carefully controlled.

Language, prosody and ToM skills in 24 children aged 9 to 16 years with HFA were assessed approximately 2 ½ years after participation in a study of language and prosody conducted at Queen Margaret University College (McCann, Peppé, Gibbon, O'Hare and Rutherford, 2006). The current study reports the skills and abilities of the children with HFA in the follow-up, using a battery of speech and language assessments, as well as assessments of expressive and receptive prosody and ToM abilities.

The majority of the children with HFA continue to show expressive and receptive language impairments, with expressive language ability continuing to be the most impaired language skill, mirroring results at Time point 1. Children with HFA are developing language along the same, but delayed, developmental trajectory as children with typical development. Strong growth was noted on prosodic ability within structured tasks, as measured by the total score on the prosody assessment, as compared to verbal-age matched typically developing children. The statistical gap that was present between groups in the earlier study no longer remains. However, children with HFA continue to perform worse on the understanding and use of contrastive stress. Children who showed atypical sounding expressive prosody in conversational speech in the earlier study continue to do so in the follow-up.

Children with HFA are developing early ToM abilities with the same developmental progression as typically developing children, but at a chronological age approximately seven years behind. However, children with HFA struggle with second-order ToM tasks.

Results show that language, prosody and ToM abilities are highly correlated. Prosody and ToM show a relationship independent of language ability. Implications of these findings to theoretical understanding, future research, as well as to speech and language assessment and intervention are presented.

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1

Introduction

> "Her language always has the same quality. Her speech is never accompanied by facial expression or gestures. She does not look into one's face. Her voice is peculiarly unmodulated, somewhat hoarse; she utters her words in an abrupt manner. Her utterances are impersonal. She never uses the personal pronouns of the first and second persons correctly. She does not seem to be able to conceive the real meaning of these words. Her grammar is inflexible. She uses sentences she has just heard, without adapting them grammatically to the situation of the moment. When she says, "Want me to draw a spider," she means, "I want you to draw a spider." She affirms by repeating a question literally, and she negates by not complying. Her speech is rarely communicative. She has no relation to children, has never talked to them. She moves among them like a strange being, as one moves between pieces of furniture in the room" (Kanner, 1943/1985, p. 40).

This description of a seven-year old girl referred to as Elaine was featured in Leo Kanner's landmark account which identified a group of children with impaired language and social interactions, as well as restricted and repetitive behaviours that he labelled infantile autism (Kanner, 1943/1985). From the start, the skill deficits and behaviours that were central to Kanner's concept of autism were determined by comparison to the skills and behaviours of children with typical development. The quote by Kanner sets the stage for this thesis which will present longitudinal findings from a study of language skills in school-age children with autism; their abilities will be compared with those of typically developing children on their performance on measures of language (including articulation/phonology, semantics, syntax, and pragmatics), prosody and a cognitive skill known as theory of mind.

Over sixty years after Kanner's original description of children with autism, much has been learned about the language and theory of mind abilities of children with autism, whilst relatively little is known about the development of their prosody skills. The study of prosody can include its understanding and use, as well as specific aspects of prosody such as accent/stress, affect and intonation, and grammatical/pragmatic distinctions. In addition to the overall dearth of research, only a few features of prosody are measured in a single study. Further, there is only a single (as yet unpublished) study that has examined the relationships between language, prosody and theory of mind (McCann & Carroll et al., 2006).

In this chapter, key terms will be defined and background information about autism, language, prosody and theory of mind will be presented, followed by consideration of how they are related. Finally, a rationale for the relevance of this study to speech and language therapy and future research will be asserted.

The layout for the rest of the thesis is as follows: Chapter 2 presents a review of relevant findings from the research literature, Chapter 3 presents the methodology used in this study, Chapter 4 presents results, Chapter 5 provides a discussion and in Chapter 6, concluding comments are made. Throughout this thesis, information will be presented in a consistent order across chapters; a discussion of language will be followed by prosody, then theory of mind and finally the relationships between them. Although prosody is a facet of language, it will be examined in great detail so as to warrant its own section for the purposes of the current study. Throughout its entirety, this PhD investigation will be referred to as the current study.

1.1 DEFINITION OF AUTISM

The understanding and description of the disorder originally described as infantile autism by Leo Kanner (1943/1985) has evolved over the years and is now called Autism Spectrum Disorders (ASDs). ASDs refer to a group of developmental disabilities (Medical Research Council, 2001) and include the subgroups Autistic disorder, Asperger syndrome (AS) and Atypical autism (also known as Pervasive developmental disorders-not otherwise specified (PDD-NOS)). In 1943, Kanner's definition of autism was narrower than it is today; he defined autism as mainly an impairment of language abilities and social interactions with concomitant ritualistic behaviours (Boucher, 1996). By the most current definition, individuals with ASDs display significant impairment across three areas: social interaction; communication skills; and presence of repetitive, obsessive behaviours and interests; all of which manifest themselves by the time a child reaches 36 months of age (World Health

Organization, 1992; American Psychiatric Association, 1994). Individuals with ASDs have skills on a continuum which ranges from those with profound cognitive and communicative impairments to those with above average cognitive and language skills but with mild to severe social interaction impairments (Wing, 1991). For reference, approximately 30 - 50% of all individuals with ASDs have concomitant cognitive impairments (Fombonne, 2003; Fombonne, 2005; Volkmar, Lord, Bailey, Schultz & Klin, 2004; Baird et al., 2006).

There are varying outcomes for those with ASDs, depending on the severity of the associated symptoms, as well as provision of appropriate education and specialist interventions; however ASDs are a lifelong disability (Medical Research Council, 2001). Individuals with ASDs are frequently described as heterogeneous; therefore, while they share many core characteristics, they have variable strengths and weaknesses in skills that span a wide developmental range (Kjelgaard & Tager-Flusberg, 2001); this is unlike typically developing children who tend to have more evenly distributed abilities (Frith, 1998).

1.1.1 High-Functioning Autism

High-functioning autism (HFA) refers to a subgroup of individuals on the Autistic Spectrum who have Autistic disorder; this subgroup is separate from groups of individuals with Asperger syndrome or Atypical autism. HFA is not an officially recognised category within either of the two gold standard diagnostic manuals: the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM IV, American Psychiatric Association, 1994) or the International Classification of Diseases, 10th Edition (ICD-10, World Health Organization, 1992). Nevertheless, the term HFA has been widely used to refer to a group of individuals having evidenced a preschool language impairment whilst non-verbal cognitive skills are within the normal range (Baltaxe and Simmons, 1992; Tsai, 1992; Waterhouse, 1996; Gillberg & Ehlers, 1998; Szatmari, Bryson, Boyle, Streiner, & Duku, 2003; Howlin, 2003; Starr, Szatmari, Bryson & Zwaigenbaum, 2003; Klin, McPartland & Volkmar, 2005; Landa & Goldberg, 2005). Children with HFA are the focus of the current study and therefore information will be presented from literature pertaining to this group; however where no specific information is available, or where important to the context, children with ASDs will be discussed.

The prevalence of ASDs has been reported as approximately 60 per 10,000 persons worldwide (Fombonne, 2005), however a recent prevalence study conducted in Southern England reported the total prevalence of ASDs to be 116 per 10,000 (Baird et al., 2006). Males outnumber females by a ratio of 4.3 to 1(Fombonne, 2005). Of an estimated total of 535,000 people in the United Kingdom with ASDs, approximately 46,700 children have HFA (National Autistic Society, 2006).

1.2 DEFINITIONS OF SPEECH, LANGUAGE AND COMMUNICATION

1.2.1 Speech

Speech refers to a verbal method of communication and encompasses two types of acoustic features, segmental and non- or supra-segmental (Owens, 2005). Segmental features are the distinctive sounds of individual phonemes in connected speech (Crystal, 1994) while non- or supra-segmental features refer to vocal intonation, stress, pitch timing and rhythm (Crystal, 1994). Others view supra-segmental features as components of communication, rather than speech (Owens, 2005, Twachtman-Cullen, 1998) (see section 1.2.3).

1.2.2 Language

Language is "a socially shared code or conventional system for representing concepts through the use of arbitrary symbols and rule-governed combinations of these symbols" (Owens, 2005, p. 7). Bloom and Lahey (1978) defined language specifically for the purpose of understanding its early development as well as understanding how children with language deficits can be helped to develop and improve language skills. They described language as being comprised of three main components, content, form and use. Content refers to semantics (word meanings and categorisation of objects, actions and possessions). Form is described as the interaction of signals (e.g. sounds, signs) with semantics (Bloom & Lahey, 1978) and includes morphology (units of meaning that are words or inflections), phonology (organised units of sound) and syntax/grammar (the ways in which units of meaning are combined with one another). The use of language, or pragmatics, is further differentiated into two main aspects; the first is the goal or intention of language (why a person speaks/signs/writes a particular utterance) and the second is the synthesis of linguistic and/or non-linguistic context made by the listener in order to understand the true intention of the speaker. Finally, Bloom and Lahey (1978) asserted that both reception and expression of language require integration of content, form and use.

1.2.3 Communication

The terms speech, language and communication have often been used interchangeably; however they refer to separate, but related, aspects of development. Communication is the process of exchanging ideas and information through encoding, sending and ultimately interpreting the intention of a message and may or may not involve language (Owens, 2005). Frith and Happé (1994) stated "language and communication are separate and logically distinct things" (p. 97) since communication can occur through other ways such as use of unconventional gestures, eye gaze and body movements. Communication via speech and language involves aspects which can enhance, monitor, or change messages or meanings and includes 1) paralinguistic features (e.g., intonation, stress, rate, use of pauses or hesitations (also known as supra- or non-segmental features (Crystal, 1994; see section 1.2.1)), 2) the aforementioned non-linguistic cues such as gestures, body movements, posture, proxemics and facial expressions, and 3) metalinguistic skills (the ability to analyse, judge and talk about language).

Pragmatic skills are necessary to competently amalgamate speech and language into communication. Owens (2005) defined a competent communicator as one who "is able to conceive, formulate, modulate and issue messages and to perceive the degree to which intended meanings are successfully conveyed" (p. 11). Sperber and Wilson (1986) argued that human communication is an inferential process that requires the speaker and the listener to make conjectures about the state of mind of the communication partner. This theory implicates prosody and theory of mind, as will be discussed in Section 1.5 (p. 14).

1.2.4 Speech, Language and Communication in Children with ASDs/HFA

As with all individuals with ASDs, the skills of individuals with HFA can be as dissimilar as they are similar; however specific characteristics must be present in early childhood in order to confirm the initial diagnosis. According to most current diagnostic criteria from ICD-10 and DSM IV (World Health Organization, 1992; American Psychiatric Association, 1994), the core features of disordered language and impaired social communication in a child with ASDs and HFA may include the following: markedly deficient regulation of social interaction; diminished or lack of eye contact; absent or delayed expressive speech (often preceded by a lack of babbling); a lack of use of gestures to provide emphasis or aid meaning; pronoun reversals; use of neologisms; echolalia; inadequate attempts to initiate or sustain a conversation; repetitive or idiosyncratic language; poor flexibility in language expression; impaired use of variations in cadence or emphasis to reflect communication modulation; and impoverished dramatic and pretend-play skills. These deficits, therefore, pervade the content and form of language (semantics, morphology, syntax) and its use (pragmatics), as well as overall communication ability.

Language deficits are present in children with many types of developmental disorders. Any of the above characteristics may be noted in other clinical conditions; however they present differently in children with ASDs/HFA. For example, children with Down syndrome may be significantly impaired in their expressive language but are not usually impaired in their use of gesture (Woll & Grove, 1996), play skills or desire for initiating and sustaining conversation (Kumin, 2006). However, current research provides evidence that the boundaries between ASDs/HFA and conditions such as specific language impairment and pragmatic language impairment are not always clear (Kjelgaard & Tager-Flusberg, 2001; Bishop & Norbury, 2002; Conti-Ramsden, Simkin

& Botting, 2005). For example, overall performance profiles on batteries of standardised speech and language assessments have been found to be similar between children with specific language impairment and ASDs (Barrett, Prior & Manjiviona, 2004; Conti-Ramsden et al., 2005). Further, ASDs/HFA are known to co-occur with other conditions such as seizure disorders, tubular sclerosis and fragile X syndrome; in fact co-morbidity is possible with any other developmental condition (Volkmar & Klin, 2005).

As noted in the diagnostic profile, social communication skill deficits are a core diagnostic feature, are markedly impaired in children with HFA (Kanner 1943/1985; Wing, 1991; World Health Organization, 1992; American Psychiatric Association, 1994) and are "pathognomonic of the [ASD] syndrome" (Twachtman-Cullen, 2000, p. 239). However, social deficits are difficult to assess and quantify because pragmatic skills are by nature context-dependent, therefore formalised assessments are unlikely to reliably capture abilities or challenges in this area (Adams, 2002). Children with ASDs/HFA have challenges in initiation, topic maintenance and reciprocation in conversation (Tager-Flusberg, 1999). Particular deficits are further noted with understanding indirect requests (e.g., 'it's hard to hear the radio'), figurative language (e.g., 'you can kiss that goodbye'), as well as difficulty making presuppositions such as regulating speaking style to meet different listeners' needs (e.g. talking to a small child vs. an adult) and making judgments about what information a listener may or may not already have or need (Twachtman-Cullen, 2000).

Given that there are clearly established deficits in the language and social communication of children with ASDs/HFA, it is not surprising then that many also have difficulty understanding and using prosody, a supra-segmental or paralinguistic feature of speech and language that supports social communicative competence and is defined and described in the next section.

1.3 DEFINITION OF PROSODY

As Kanner hinted in his description of his young client, Elaine, disordered prosody is a notable feature in children with ASDs. Colloquially, most people are familiar with prosody as 'tone-of-voice' and are similarly aware that it adds emotional meaning that can either align or contrast with the words used in an utterance. Linguistically, the term prosody is broadly considered synonymous with the terms suprasegmentals, intonation, or prosodic features, although the exact definition varies among linguists (Couper-Kuhlen, 1986; Crystal, 1986; Vihman, 1996; Cruttenden, 1997). Prosody may refer to changes in loudness or intensity, vocal pitch, and syllable length that interact in a myriad of ways to shape and shade communicative functions in subtle and not-so-subtle ways. As the definition varies, so do the parameters considered to be within the domain of prosody, depending on the perspective of the linguist, researcher or therapist. This will be explored in greater detail within the literature review as individual findings will reflect these variable perspectives.

Prosody plays a particularly important role in grammatical forms such as phrase and clause division used to differentiate between two or three items (e.g. 'chocolate-ice-cream and cake' vs. 'chocolate', 'ice-cream' and 'cake'); delineating sentence-type (question vs. statement vs. request); word-class (e.g. '**pro**gress' as a noun vs. 'pro**gress**' as a verb, with the syllables in bold indicating stressed syllables); contrastive stress within utterances used for emphasis (e.g. 'I want new **shoes**' vs. 'I want **new** shoes'); pragmatic/interactional function (e.g. turn-taking, topic maintenance); and the expression of mood or attitude (e.g. emotional vs. neutral, humorous vs. serious). Further, prosody can serve multiple functions at the same time; for example, while serving the grammatical forms it is also functioning pragmatically in response to a particular context or in establishing a context. When indicating a particular word-class, prosody is serving a content function as well as a pragmatic function.

Couper-Kuhlen and Selting (1996) discuss prosody and intonation in the context of discourse, viewing them as being intricately connected with situational use of language. They state that prosody and intonation

> "constitute how something is said, not what is said, and they ultimately influence only what participants *infer* is the meaning .... They stand in a reflexive relationship to language, cueing the context within which it is to be interpreted and at the same time constituting that context (Couper-Kuhlen & Selting, 1996, p. 21)."

In other words, features of prosody often provide information which can be otherwise gleaned through context. Wilson and Wharton (in press) asserted that prosody involves subtle indications that lead the listener toward a particular interpretation as opposed to providing information which leads to a definite conclusion. Therefore, misunderstandings can occur either through misuse of a prosodic feature, or less than careful attention on the part of the listener to prosodic cues that may guide the listener away from or toward a particular meaning. Referring to the functions of prosody just presented, ambiguity can be clarified via prosodic features. For example, the utterance "She is arriving tonight" may be used as a statement of fact or to ask a question. However, if the utterance is meant to be a question, the meaning can be disambiguated by use of a rising tone at the end of the utterance. Likewise, use of a falling tone at the end of the utterance confirms that it is meant as a statement. If one wishes to specify that a list of items are to be considered as separate rather than a group, a longer pause is used after each individual item; if one is indicating a combined item, the pause time is shortened between the item names. A colleague once received an unusual (and unwanted) concoction when a bartender did not note the longer boundaries in a request made for the individual items red wine, coke and pineapple juice.

Prosody is not a feature of language that needs to be explicitly taught to typically developing children. It is different from other features of language, such as semantics and syntax, in which carers provide an exemplar model when a grammatical construction or word meaning is used incorrectly. Prosody develops from infancy, becoming most fully developed by adolescence (Wells, Peppé & Goulandris, 2004). The ease with which most children learn the implicit rules of prosodic features stands in stark contrast to those children who have not been able to grasp this seemingly effortless learning. Baltaxe and Simmons (1985) asserted that well-developed prosodic ability is the result of dynamic but complex interactions between the level of prosodic development and maturational change, along with linguistic, cognitive and pragmatic growth.

1.3.1 Prosodic Deficits

Use of unusual expressive prosody in many, but not all, children with ASDs has been reported as far back as Kanner's early account of autism (1943/1985). In subsequent research literature examining expressive speech in children with ASDs/HFA, prosody has frequently been described as sounding odd, monotonous, exaggerated, wooden or robotic (Simmons & Baltaxe, 1975; Baltaxe & Simmons, 1985; Paul & Sutherland, 2005) and may include inappropriate use of stress and unconventional patterns of intonation (Shriberg et al., 2001). When present in children with ASDs/HFA, expressive prosodic deficits are persistent even when improvements are noted in other aspects of a child's language (Kanner, 1971/1985; Simmons & Baltaxe, 1975; Paul & Sutherland, 2005) and create an immediate impression of social oddness. However, there is a significant gap in the research literature about this often impaired area as prosodic development and disorders in children with HFA remain relatively overlooked (McCann & Peppé, 2003).

Prosodic deficits have been documented in other clinical populations such as in children with motor impairments (e.g., developmental apraxia of speech; speech dysarthrias associated with cerebral vascular incidents, trauma, or neurological disorders); sensory impairments (e.g., hearing loss); developmental cognitive impairments (e.g., Down Syndrome, which also has an impaired motor component); psychological conditions (e.g., schizophrenia, clinical depression); and temporal processing deficits (e.g., specific language impairment) (Hargrove & McGarr, 1994). However, within ASDs/HFA, the cause of the prosodic deficits, when present, has not been empirically related to any one particular underlying deficit. This will be examined further in the discussion in Chapter 5.

A great deal of communicative meaning is shared via prosody. Therefore, a child with HFA, who already has poor social communicative skills, will be even more disadvantaged if the meanings conveyed by prosody are not understood or used effectively. Another skill that is important in communicating effectively is being able to understand the behaviour or unspoken intentions of a communication partner. This skill is known as theory of mind. Whilst the study of prosody has typically been the domain of linguists and speech language therapists and researchers, theory of mind has typically been studied by psychologists.

1.4 DEFINITION OF THEORY OF MIND

Theory of mind (ToM), also referred to as mentalising ability, meta-representational ability or inter-subjectivity, is the attribution of thoughts, feelings and ideas to others and the ability to use this knowledge to predict others' behaviour (Baron-Cohen, 1995); ToM also includes a range of mental states such as perception, intentions and emotions (Hughes, 2005). A speaker needs to assess what knowledge a listener already has, and must estimate how much detail is required to carry on a conversation. For example, if a speaker says 'She is probably going to be late, as usual', the speaker has to be sure that the listener knows to whom 'she' refers, as well as sharing the common implicit knowledge that 'she' is usually late. Another example of ToM involves modifying the content of speech to avoid hurting or embarrassing the communication partner, such as responding positively to a question such as 'How do you like my new haircut?' even when the speaker does not think the communication partner's haircut is flattering. With an intact ToM, a person is able to reflect on the contents of one's own and others' minds, a skill that is essential for socially competent behaviour (Wellman, 1990). Therefore, developmentally appropriate ToM abilities are critical for daily communication as well as for educational success (Astington, 1998). ToM, as measured by false-belief tasks, is present in typically developing children by 4 years of age. A classic example of a false-belief task would be to present a container with predictable contents, such as a coloured pencil box and to ask the child to tell what he or she would expect to be in the box. Naturally, the child would state that the box contained coloured pencils. Then, unexpected objects such as pebbles would be revealed as the contents. The child would then be asked to guess what a new observer, who did not see inside the box, might guess was inside. Using a ToM, the child would state that a new observer would guess that the box contained coloured pencils, even though the child knows there is something else in the box. To do this, the child needs to understand that another observer would not have access to the same information without seeing inside the container and therefore would not have the same knowledge that he/she has. It requires an individual to take into account the perspective of another. A lack of this skill has been described as mind-blindness (Baron-Cohen, 1995).

Over the last several years, research has considered ToM to encompass a much broader range of skills than simply the false-belief task. For example, joint attention, a skill that develops in typical infants in the first year of life, has been considered to be an early theory of mind skill (Baron-Cohen, 1995). At the other end of ToM development are more complex abilities in which one person must understand what another person thinks a third person will do (known as a second-order task). Other higher order ToM tasks involve understanding of lies, white lies, irony, figurative language and metaphors (Happé, 1994).

Typically developing children learn the nuances of mentalising without direct instruction, but not effortlessly; there is evidence that it develops most efficiently in those children who are raised in families in which discussions about other people's perceptions and expectations occur on a regular basis (Dunn, 1999; Woolfe, Want & Siegal, 2002; Dunn & Brophy, 2005). Broader social environmental factors such as type of school attended, opportunities for and quality of peer relationships also have an important role in ToM development (Hughes, 2005). Further, studies examining ToM acquisition in Western vs. non-Western children have provided evidence of cultural effects on the order with which some ToM skills are obtained. For example, typically developing Chinese preschool children learn about the importance of accessing the correct information before learning that two individuals may have divergent beliefs. (Wellman, Fang, Liu, Zhu & Liu, in press). This is a different order of ToM development as compared to American or Australian typically developing preschool children (Wellman & Liu, 2004; Peterson, Wellman & Liu, 2005) and is considered to reflect the divergent cultural values placed on these concepts.

By adulthood, typical individuals are generally able to comprehend complex ToM. Entertainment programmes rely heavily on multiple layers of understanding and misunderstandings about characters (e.g., 'He said you said he knows that she knows'). Individuals may have difficulty anywhere along the continuum from the most basic to highly complex ToM understanding. Conversely, there are individuals who use an intact ToM in a negative way such as to bully, purposely confuse, or deceive; others may use competent ToM skills in a more benevolent way to affect pro-social change (Slaughter & Repacholi, 2003) or to entertain.

1.4.1 Theory of Mind Deficits

ToM has been an important area of inquiry into individuals with ASDs; deficits in ToM skills are evident in the majority of children with ASDs, including those with HFA (Baron-Cohen, Leslie & Frith, 1985; Baron-Cohen, 1989). These deficits range from a delay in acquisition of skills to an inability to complete tasks of various levels. Important information has also been gained through comparison to control groups of typically developing children as well as with language and/or cognitively impaired children. Findings have consistently demonstrated that children with ASDs/HFA perform significantly worse than typically developing children. Children with ASDs/HFA also perform worse than children who evidence ToM delay, including children who are deaf and living with families not fluent in sign language, those with cognitive impairments due to developmental delays such as Down syndrome or Williams syndrome, and individuals with specific language impairment (Yirmiya, Erel, Shaked & Solomonica-Levi, 1998; Tager-Flusberg & Joseph, 2005).

ToM ability has been shown to correlate highly with standardised language assessment measures of vocabulary and syntax (Dahlgren & Trillingsgaard, 1996; Tager-Flusberg & Sullivan, 1994; McCann, Peppé, Gibbon, O'Hare & Rutherford, in press) and cognitive ability (Peterson et al., 2005) in typically developing children and those with ASDs. There is particular interest in the role of sentential complements in the development of ToM and evidence that children with ASDs are especially dependent on the understanding of this grammatical knowledge "to bootstrap their meta-representational capacity" (Tager-Flusberg & Joseph, 2005, p. 301).

1.5 LANGUAGE, PROSODY AND ToM

This chapter began with Kanner's description of Elaine, a seven-year old girl with ASD. She had an IQ of 83 (Kanner, 1971/1985), which by current classification would be described as HFA. Kanner commented on her odd (perhaps monotonous) prosody, stating her "voice was peculiarly unmodulated;" he labelled her utterances as "impersonal" and he wrote that she did not adapt her speech "to the situation of the moment" thus possibly indicating impoverished pragmatic and/or ToM skills. Kanner also noted her grammar was "inflexible," indicating difficulty with generative language and that she had "no relation to children, has never talked to them" which is clearly indicative of poor social interaction and pragmatic skills (Kanner, 1943/1985, p. 40).

Previous research has demonstrated a clear connection between language skills and theory of mind (Jenkins & Astington, 1996; Hughes & Dunn, 1997; Cutting & Dunn, 1999; Ruffman, Slade, Rowlandson, Rumsey & Garnham, 2003; deVilliers and deVilliers, 2003) as well as between language and prosody (Paul & Shriberg et al., 2005; McCann et al., in press). Language content and form, pragmatics, prosody and ToM all require an understanding or inter-subjective connection with a communication partner to a greater or lesser extent, depending on the communicative context. In fact, Tanguay, Robertson and Derrick (1998) defined social communication as "the communication of cognitive and emotional information through facial expression, gesture, and prosody and through implicit understanding of pragmatics and of theory of mind" (p. 271). Table 1-1 shows how these areas may be related by comparing each to a specific aforementioned prosodic function.

Table 1-1. Matrix Comparison on Overlaid Functions of Prosodic Functions with Language Form, Language Function and Theory of Mind

Prosodic Functions	Language Content & Form	Language Function (Pragmatics)	Theory of Mind
Affect-emotion	Choice of words to express level of emotion	Understanding and desire to tailor utterances to describe or share emotional state	Understanding of another's emotional state
Grammatical – phrase delineation	Use of 'and' or 'with' to support understanding	Awareness of need to disambiguate	Awareness of other person's possible misinterpretation
Grammatical – questions vs. statement	Use of question words to clarify	Awareness of need to disambiguate	Awareness of other person's possible misinterpretation
Within-word stress to signal verb vs. noun	Use of word order to clarify noun or verb	Awareness of need to disambiguate	Awareness of other person's possible misinterpretation, attention to the other person's communicative intent
Contrastive stress – to highlight new or important information	Use of syntax to clarify (e.g., "no I didn't want the white one, I wanted the blue one")	Awareness of need to tailor information specifically to assist the listener in understanding	Awareness of other person's perspective and possible misinterpretation

Given the noted difficulties that children with HFA have with language, pragmatics, prosody and ToM, as well as the similarities shared by these areas, it may well be that all are the result of the same underlying difficulty in children with HFA, such as impoverished joint attention skills in infancy. All are frequently impaired in children with HFA, and singly or collectively these deficits render a child with HFA more vulnerable to social and educational displacement. Prosody skills have been relatively neglected in research (McCann & Peppé, 2003). Therefore it is important to study the development of prosodic skills over time and its relationship to language and ToM. As the current study research aims and hypotheses will show in the following chapter, it is expected that a relationship will exist between language, prosody and theory of mind, although at this stage the nature and extent of any such relationship remains unclear. Are language, prosody and ToM independent skills, or are they facets of the same underlying skill? Does prosody function independently of ToM or it is a phonetic carrier of ToM? The aims of the current study are to reveal evidence as to whether language, prosody and ToM reflect a central, related deficit or perhaps interact in a more linear relationship.

1.6 RELEVANCE OF STUDY

Speech and language therapists (SLTs) rely on high quality empirical evidence to guide their assessment and interventions for children with communication challenges. Knowledge of strengths and skill deficits, continuity and change in these individuals impact the recommendations for intervention made by SLTs to parents and educators, as well as others professionally involved in the care of children with communication impairments. This knowledge also continues to be critical to researchers in the field of ASDs.

The developmental course for children with HFA has not been studied extensively (Tager-Flusberg, 2000b; McGovern & Sigman, 2004). Most longitudinal studies of language and cognitive abilities have been "conducted with lower functioning children with autism so that the extent to which the results are generalisable to higher functioning children with autism ... are unknown" (Szatmari et al., 2003, p. 520). Whilst children with HFA have, by definition, had a language delay in their preschool years, research evidence indicates that language skills can improve greatly from childhood through adolescence in many, but not all, children with HFA (Shea & Mesibov, 2005). However, it is unclear whether they become more or less delayed relative to their typically developing peers.

Knowledge of the development of language through the school-aged years in children with ASDs/HFA is critical to future speech and language intervention planning as well as improving their access to general educational curricula in inclusive settings. Further, research findings indicate that language skills can predict outcomes in socialisation, communication (Venter, Lord & Schopler, 1992; Szatmari et al, 2003) and overall prognosis (Rutter, 1970).

Children with HFA have been shown to have significant challenges with social communication which persist or even increase as social interactions become more dynamic and language more frequently represented with non-literal terms and figurative expressions (Cantwell, Baker, Rutter & Mawhood, 1989). Higher-level, complex language skills such as social discourse and formation of cohesive narratives will continue to be disordered throughout the school years and beyond (Tager-Flusberg, 2000a). Social communication deficits in children with HFA can be marked and debilitating in daily functioning, however these challenges may be masked by fluent verbal expression and cognitive strengths, even exceptional cognitive abilities (Marans, Rubin & Laurent, 2005; Rice, Warren & Betz, 2005). The social communication challenges in children with HFA are a significant factor in the prominent discrepancy that exists between strong cognitive abilities and impoverished adaptive functioning seen in both routine and novel activities or interactions that occur in daily life (Rubin & Lennon, 2004). Orsmond, Krauss and Seltzer (2004) found that the adolescents with ASDs who had the most impaired social interaction skills had the fewest peer relationships; almost half were reported to have no peer relationships outside employment settings or social gatherings arranged by parents or carers. Social interactions can be additionally hampered by impaired understanding and use of prosody and poor ToM abilities. Therefore, a child with HFA, who already has poor social communicative skills, will be even more vulnerable to social and educational displacement if the nuances of prosody and ToM are not understood or used effectively.

While ToM has been studied extensively, with more than 750 published studies on the topic between 1985 and 2000, only a few studies have considered prosody as a contributing or controlled factor when assessing ToM ability (McCann & Carroll et al., 2006; Rutherford, Baron-Cohen & Wheelwright, 2002). No published studies have looked at the relationship between performance on ToM and prosody assessment protocols in children with HFA, although McCann and Carroll et al. (2006) have recently investigated this relationship in children with Asperger syndrome. Both prosody and ToM provide cues to the individual that assist in the understanding of meaning within a given utterance or situation that may or may not be explicitly stated by word choice alone; in fact, information from prosody or ToM might indicate that the speaker means the opposite of the words alone. Thus, investigating the relationship between language, prosody and ToM may shed light on a possible core deficit in children with HFA and have important implications for clinical assessment and interventions with these children as well as further research evidence in the study of HFA. Therefore the current study seeks to elucidate the relationship between language, prosody and ToM, to describe the nature of such a relationship and to formulate further understanding about how deficits in these areas might be remediated.

1.7 SUMMARY

This chapter presented an overview of working definitions of key terms as well as theoretical assumptions. Additionally, it provided an overview of the current study, its desired outcomes and relevance to research and the field of speech and language therapy. The next chapter provides a review of the research literature on the language, prosody and ToM skills and deficits in children with HFA, followed by the specific aims and hypotheses for this study.

2

Literature Review

This chapter will present a review of the literature pertaining to the language, prosody and ToM skills and deficits in children with HFA, with comparison to information about children with typical development. This review will focus on children with HFA, rather than those within the broader autism spectrum; however where there is only information available about skills of children with ASDs, that information will be presented. Additionally, the focus will be on information about school-age and adolescent children as they will be the participants in the current study, yet where comparable information is lacking there may be reference to skills of younger children or adults. The bulk of the information regarding skills of children with typical development will be from normative data in standardised assessments. Finally, the specific aims and hypotheses for the current study will be delineated.

2.1 LANGUAGE

2.1.1 Language and Communication Skills in Children with HFA

Impaired language and communication are two of the three defining characteristics of ASDs/HFA in the current diagnostic criteria (World Health Organization, 1992; American Psychiatric Association, 1994) and as such they are important features to examine. As discussed earlier, heterogeneity of language and communication skills complicates the study of deficits in this area; however communication abilities in children with ASDs are uniquely flawed (Baltaxe & Simmons, 1992). For example, the developmental progression of communication and pragmatic skills in children with ASDs have been found to be deviant due to gaps in the sequential development of skills as compared to children with typical development (VanMeter, Fein, Morris, Waterhouse & Allen, 1997). ASDs are frequently first suspected in a child as a result of abnormal or delayed speech and/or expressive language (Tager-Flusberg, Paul & Lord, 2005);

deficits in these skills are usually cited by a family member or carer as the primary area of concern about a young child's development. Additionally, the level of expressive language achieved by the age of five years is an important prognostic indicator of HFA vs. lower functioning ability levels within the autism spectrum (Rutter, 1970).

It is important to recall that the definition of ASDs has changed over the years when comparing results across studies; older studies have used different diagnostic criteria which prevent full comparisons with more recent studies. Additionally, Howlin (2004) cautioned that comparing and contrasting between results of studies must be done carefully due to differences in sample selection criteria and different measures used for assessments.

2.1.1.1 Delay versus Deviance

The term delay generally refers to structures or constructs (e.g., cognition, speech, language, communication) that develop in the same order, but at a later age, as children with typical development. Deviance refers to structures which are present that do not occur in typically developing children, or develop in a different sequence than those with typical development (Crystal & Varley, 1998). Conceptually, however, the distinction between delay and deviance is not completely clear. VanMeter et al. (1997) provided the following example to clarify (or at least to highlight how these terms are unclear); if a child has receptive language within the normal range, but is delayed in expressive language skills, then overall language ability could be considered deviant because typical children do not develop receptive and expressive skills in such a disparate way. However, when considered individually, expressive language may be delayed, as those skills are slower to develop but occur in the same order as children with typical development. Thus, the designation of delayed or deviant abilities requires consideration of the parameters within which the question arises (VanMeter et al., 1997). The question of delayed vs. deviant abilities is an important one, as the findings can help to understand the mechanisms that underlie impairments, as well as to inform etiological considerations and implications for prognosis and appropriate interventions (Rice et al., 2005).

2.1.1.2 Articulation/Phonology

There has been mixed information regarding the phonological and articulation abilities of children with ASDs/HFA. Early studies comparing abilities of children with ASDs to language-level matched groups with language impairments found the articulation skills of children with ASDs to be superior (Boucher, 1976) or comparable (Bartolucci, Pierce, Streiner, & Eppel, 1976; Tager-Flusberg, 1981). Boucher (2003) noted that phonology is the strongest language ability in children with ASDs. As part of their study of language skills in children with ASDs, Kjelgaard and Tager-Flusberg (2001) investigated articulation abilities using the Goldman-Fristoe Test of Articulation in 89 school-aged children (mean 7;04 years). They subdivided their sample into groups of those who could and those who could not complete the Clinical Evaluation of Language Fundamentals (CELF) test, thus creating a smaller group of 44 children (mean 7;03 years), who were able to complete the CELF. Of these children, the range of non-verbal IQ scores was 43-153 with a mean of 83; thus the authors described this group of children as HFA. This smaller group scored within the normal standard score range on the Goldman-Fristoe. Additionally, even the group of children in their sample who could not complete the CELF scored within the normal range, although this group's scores were significantly lower than the group that did complete the CELF. Thus Kjelgaard and Tager-Flusberg (2001) concluded that single word articulation abilities are spared in children with ASDs/HFA.

There is contrary evidence, however, that indicates articulation abilities are variable in children with HFA and not universally within the normal range. McCann et al. (in press) found that, whilst their group of 31 children with HFA (mean 9;09 years) had better single word articulation skills compared to other measures of expressive and receptive language, 20% (n = 6) scored within a mild to significantly impaired range as compared to children with typical development. Gibbon, McCann, Peppé, O'Hare and Rutherford (2004) provided further details about these findings, noting that of the six children with impaired articulation, four had deviant skills based on the number of atypical sound substitutions. Shriberg et al. (2001) assessed articulation abilities in the connected speech of 15 older individuals with HFA who ranged in age from 10 to 49 years (mean 21;06 years) and compared their abilities to those with typical development within the same age range. They found that 33.3% of the HFA group had residual articulation errors, which is much higher than the 1% - 2% prevalence rate of articulation errors in typical adults (Flipsen, 1999 as cited in Shriberg et al., 2001). Wagner and Nettelbladt (2005) provided additional evidence of the presence of articulation/phonological impairments via a single longitudinal case study of a boy with HFA. At the age of 3;10 years he was noted to have severely impaired phonology characterised by "context-sensitive reductions such as assimilations and syllable deletions" (p. 127). However, this report was more encouraging than the findings by Gibbon et al. (2004) and Shriberg et al. (2001); by 5;06 years the boy's expressive phonology had improved enough that it had almost reached age-appropriate levels (Wagner & Nettelbladt, 2005). While articulation skills may be intact in most children with ASDs, a significant minority have been shown to have difficulty with these skills. Therefore, it does not appear that there is justification for the claim by Kjelgaard and Tager-Flusberg (2001) that these abilities are spared in all children with ASDs/HFA.

2.1.1.3 Grammatical Skills

Whilst grammatical abilities in children with HFA have not been thoroughly researched (Boucher, 2003), several findings concur that grammatical development is impaired only to the extent that skills are commensurate with overall developmental level. For example, in a review of studies investigating language abilities in ASDs, Tager-Flusberg (1981) concluded that grammatical abilities develop at a slower rate, but otherwise progress along a similar course to children with language delays and those with typical development. Paul and Cohen (1984) also reported delayed but continuing development and added that grammatical growth plateaus by adulthood.

Kjelgaard and Tager-Flusberg (2001) found that grammatical skills as assessed by the CELF test were impaired in a group of children with HFA (mean 7;04 years). Within the CELF, grammatical skills are assessed in subtests that simultaneously assess semantics and working memory. The group mean scores were more than 1 SD below the mean. Additionally, results indicated that there was not a significant difference between grammatical and vocabulary skills. Jarrold, Boucher and Russell (1997) found both expressive and receptive grammatical skills were intact to the same extent as vocabulary ability. The authors did not specify if their subjects had HFA, although they did note that many of the 120 children had "superiority of non-verbal ability over verbal ability" (p. 73) indicating that at least a portion of their group had HFA. Unfortunately, the authors did not report scores for the measures of grammar; they reported only the difference between mean scores.

A more recent study by Landa and Goldberg (2005) assessed expressive grammatical ability in 19 children with HFA (mean 11;01 years) using the Formulated Sentences subtest of the CELF-R and compared results to a group of typically developing children matched for chronological age, gender and full-scale intelligence quotient (IQ). The children with HFA performed significantly worse than the TD controls ($p = .01$), with a mean subtest score of 7.21 (*SD* 2.74), which is just within the average range (subtest standardised score mean 10, *SD* +/-3). McCann et al. (in press) reported evidence of receptive grammatical impairment in 61% of 31 children (mean 9;09 years) with HFA. Additionally, there was no significant difference in this group's performance on measures of grammar and vocabulary, thus replicating previous findings (Jarrold et al., 1997; Kjelgaard & Tager-Flusberg, 2001).

There is some evidence that syntactic abilities are deviant in children with HFA. Volden and Lord (1991) found that 20 children (mean 13;03 years) with HFA produced significantly more non-developmental errors in syntax as compared to three control groups: 1) 20 children with ASDs (but not HFA) matched on chronological age, 2) 20 children with cognitive impairments matched on chronological age and 3) a slightly younger group of 20 children with typical development (mean 12;01 years). Volden and Lord (1991) suggested this finding supported the possibility that linguistic deviance exists in children with HFA. Additionally, Baltaxe and Simmons (1992) reported the ongoing presence of expressive syntactical and morphological errors in adolescents with HFA.

Overall, the majority of findings indicate that grammatical ability is delayed in many children with HFA, with at least two studies reporting evidence of deviant development.

2.1.1.4 Vocabulary

It has been reported that some children with HFA perform well above the population mean on tests of vocabulary comprehension and may develop extensive vocabularies, thus vocabulary ability may represent an area of relative strength (Paul, 1987; Tager-Flusberg, 1981; Jarrold et al., 1997; Tager-Flusberg et al., 2005). These reports were supported in a small study comparing vocabulary skills of children with HFA to those with typical development. Dennis, Lazenby and Lockyer (2001) reported that eight children with HFA (mean 9;09 years) scored within the average range and with no statistically significant difference from the control group, although the HFA group did show a much greater variance in the range of scores as compared to the control group. However, the authors included four children with Asperger syndrome which may have positively influenced the results, as children with Asperger syndrome do not have a documented early delay in language skills (ICD-10, World Health Organisation, 1992).

There is contrary evidence that indicates vocabulary skills are impaired in children with HFA. Venter et al. (1992) assessed receptive vocabulary skills in 54 children (mean 14;08 years) with HFA and reported a mean group standardised score that was 2 SD below the population mean. Kjelgaard and Tager-Flusberg (2001) found their group of 44 children with HFA (mean 7;04 years) scored just below the average standard score range on both receptive and expressive vocabulary tests with great individual variation in ability across participants (receptive scores ranged from 55-134, expressive vocabulary scores ranged from 40-136). Results from a recent study also indicate that vocabulary skills are not preserved in children with HFA; McCann et al. (in press) noted that just over half (52%) of 31 children with HFA (mean 9;09 years) scored in the impaired range on a test of receptive vocabulary. Overall, there is some evidence that children with HFA have impaired vocabulary skills.

2.1.1.5 Semantics

In a review of language abilities and disabilities in children with HFA, Boucher (2003) described semantic abilities as being moderately impaired, noting a tendency to interpret meanings, particularly abstract meanings, inflexibly. Tager-Flusberg (1981) found children with HFA were significantly worse in their use of a semantic strategy to aid comprehension and suggested that they were unable to apply specific information about objects or people to their linguistic knowledge. Moreover, Tager-Flusberg (1992) found that a group of six children with ASDs, the majority of whom had HFA, used significantly fewer mental state terms (e.g., dream, forget, guess) than a comparison group of children with Down syndrome, matched on chronological age and language level. As well as providing further evidence about reduced semantic knowledge, these findings also have important implications about the difficulties children with HFA have with ToM ability, as will be discussed in Section 2.3.4.

Volden and Lord (1991) found that as verbal abilities increased in 20 children (mean 13;03 years) with HFA, so did the frequency of use of idiosyncratic language as compared to three control groups. In their study, idiosyncratic language was defined as "the use of conventional words or phrases in unusual ways to convey specific meanings" (Volden & Lord, 1991, p. 111). The children with HFA produced sentences such as 'It makes me want to go as deep as *economical* with it' and 'They're having a meal and then they're finishing and *siding* the table' (Volden & Lord, 1991, p. 118).

Other studies have reported more positive findings. Minshew and Goldstein (1993) studied the use of semantic organisation strategies in a group of individuals with HFA (age range 12 – 40 years, mean 20;09 years) and a control group matched on chronological age and full-scale IQ; as a result, the authors reported that individuals with HFA were as capable in their ability to conceptually categorize vocabulary terms as those with typical language ability. Dennis et al. (2001) reported eight children with HFA or Asperger syndrome (mean 9;09 years) appeared able to identify multiple word meanings which indicated the presence of linguistic flexibility; however this positive finding may be a reflection of the higher language ability generally reported in those with Asperger syndrome (Ghaziuddin & Mountain-Kimchi, 2004). Thus, the findings on semantic abilities in children with HFA are inconclusive due to the limited empirical results. However, based on this narrow evidence, it appears that children with HFA are heterogeneous in their semantic skills and have particular difficulty with abstract, non-literal meanings with a tendency to use words in an odd or idiosyncratic manner.

2.1.1.6 Expressive Language

McCann et al. (in press) reported that expressive language ability, as measured by the expressive subtests of the CELF-3, was the most impaired language skill in their group of 31 children with HFA (mean 9;09 years); ninety percent of the group scored within the impaired range, with the majority of these children receiving scores which fell more than 2 SD below the population mean. Kjelgaard and Tager-Flusberg (2001) reported similar findings with their group of 44 children with HFA (mean 7;03 years); as a group the mean standard score fell more than 1.5 SD below the mean. Additionally, Kjelgaard and Tager-Flusberg (2001) noted that the group performed most poorly (and lower than 1 SD below the mean) on the Formulating Sentences subtest, a task for which a child must generate a syntactically correct sentence about a picture provided whilst using a word given by the examiner in a semantically correct way. The HFA group scored just within the average range on the other two expressive subtests of the CELF (Recalling Sentences subtest and Sentence Assembly subtest). Kjelgaard and Tager-Flusberg (2001) called attention to the broad variability of performance across individual participants, noting that this heterogeneity prevented a unifying profile of language abilities and challenges from emerging. Lloyd, Paintin and Botting (2006) reported a similar finding on the same subtests from the CELF in a group of 10 slightly older children (mean 8;03 years) with ASDs (9 had HFA). Their group of children scored above the mean on the Formulated Sentences subtest but below the mean on the Recalling Sentences subtest, with great individual variation apparent in large standard deviations. Landa and Goldberg (2005) reported that whilst 19 children with HFA (mean 11;01 years) scored just above the mean on the Formulated Sentences subtest of the CELF, they scored significantly worse than a control group matched on chronological age, gender and full-scale IQ. Thus, research evidence is substantial in demonstrating that expressive language skills are deficient in the majority of children with HFA, and as individuals, they have a striking heterogeneity of skills.

2.1.1.7 Receptive Language

Tager-Flusberg (1981) found children with HFA performed significantly worse than control groups in their use of a semantic strategy to aid comprehension and posited that deviant semantic skills most likely account for poor comprehension abilities. Happé and Frith (1996) suggested that impaired ability to understand non-literal meanings causes individuals with HFA to make conspicuous comprehension errors. Eisenmajer et al. (1998) conducted a study of 108 children (mean 11;08 years) with ASDs, including those with Asperger syndrome, HFA and children who were only noted to have autistic features. The investigators grouped participants into those who did and those who did not have history of early language delay. Using retrospective data, results indicated those with a history of early language delay had significantly lower receptive language ability than the children who did not have an early delay. Combining this information with the aforementioned findings on receptive vocabulary and grammatical ability indicates that receptive language skills are impaired in the majority of children with HFA.

2.1.1.8 Pragmatics

As discussed in Chapter 1, presence of pragmatic deficits is one of the diagnostic criterion for ASDs (World Health Organisation, 1992; American Psychiatric Association, 1994). Individuals with HFA may "fail to engage in interactional conversation, are overly literal, tangential, and may talk at great length on socially inappropriate or obscure topics" (Ozonoff & Miller, 1996, p. 453) and their interactions may be overly exact and pedantic (Happé & Frith, 1996). Pragmatic ability has usually been assessed either through description of problematic areas as compared to what is expected in typically developing children, via specific assessment tools, and/or through checklists or questionnaires.

Joseph, Tager-Flusberg and Lord (2002) found that overall communicative competence as assessed with the Autism Diagnostic Observation Schedule was highly related to verbal ability in 47 children with HFA (mean 8;11 years). Ozonoff and Miller (1996) measured pragmatic ability in 17 adults with HFA (mean 26 years) by examining their ability to 1) choose the correct humorous ending to a joke presented via recorded narrative, 2) make a correct inference after hearing a sentence describing an event and 3) respond correctly to an indirect request given by a character in a story. The HFA group performed significantly worse than an age and IQ-matched control group on all three measures. Thus, the authors concluded that the HFA group showed global pragmatic impairments.

Surian, Baron-Cohen and Van der Lely (1996) assessed pragmatics in eight children with HFA (mean 12;11 years), comparing their performance to a group of children with specific language impairment and a group of children with typical development, all matched on verbal mental age. The group with HFA performed significantly worse than both control groups on tasks which required them to detect pragmatic violations in vignettes presented on audio tape, such as responding to a question without providing the requested information (e.g., 'How would you like your tea?' – 'In a cup'), responding to a question with irrelevant information (e.g., 'What would you like for breakfast' – 'A hard boiled egg cooked in hot water in a sauce pan'), and distinguishing between a rude or polite response. Although the HFA group was worse at these tasks than the control groups, three of the eight children with HFA performed significantly above chance. Dennis et al. (2001) assessed eight children with HFA (mean 9;09 years) on their ability to make inferences and found that whilst the group was able to make some inferences about mental state verbs, they failed to be able to infer what the mental state verbs meant when presented in context.

Volden (2004) reported mixed results for a group of nine younger children with HFA (mean 7;07 years) on their ability to repair communication breakdowns as compared to a control group matched by language level. On the one hand, the children with HFA were as likely as the control group to respond to requests for clarification to examiner controlled communication breakdowns. However, the children with HFA were more likely to respond to a request for clarification with a response that was "bizarre, shifted the topic, attempted to discontinue the interaction or that was otherwise inappropriate" (Volden, 2004, p. 185). Thus, the HFA group, although older and more cognitively able (as measured by non-verbal cognitive ability) evidenced poorer pragmatic skills despite these advantages.

Across these studies, findings indicate that significant pragmatic deficits are consistently present in children with HFA, as is expected based on their inclusion in the diagnostic criteria. Such pragmatic impairments differentiate children with HFA from those with typical development as well as those children with other developmental disorders. For example, children with specific language impairment may or may not have pragmatic impairment, and when they do, it is of a lesser severity than that seen in children with HFA (Bishop, 1997).

2.1.1.9 Language Development over Time

(1971) provided follow-up results of eight of the eleven children originally described in his 1943 report, which first recognised autism as a distinctive developmental disorder. Whilst the information is descriptive in nature and does not include specific detail regarding language or non-verbal cognitive scores, it does make apparent the highly disparate outcomes of a group of individuals who had been remarkably similar 28 years earlier. It is unclear whether or not all these individuals could truly have been classified as having HFA, although IQ scores in or above the average range were reported for three individuals. Only two children found employment; one received a degree, worked in a bank and lived independently; the other continued to live with his parents and was successfully employed in a sheltered workshop. The remaining six individuals all lived in long-term care facilities. Of these six, two remained non-verbal and the other four had minimal language skills. Kanner (1971/1985) noted that these children had been raised in institutions alongside children with severe cognitive impairments or psychotic adults, receiving only custodial care which he described as being "tantamount to a life sentence" (p. 233). Fortunately, more recent follow-up studies reflect a greater understanding of ASDs, including proactive intervention methods.

Tager-Flusberg, Calkins, Nolin, Baumberger and Chadwick-Dias (1990) reported development over an average of 18 months in six children (mean 5;03 years) with ASDs (5 had HFA) and compared results to an age- and language-matched group of children with Down syndrome. They found both groups progressed along a similar developmental course as children with typical development. Starr et al. (2003) used items from the Autism Diagnostic Interview to report change over a 2-year period in 41 children with HFA (mean 9;03 years at follow-up). They reported that although there was a significant decrease in unusual communication behaviours such as immediate echolalia and use of neologisms, the children showed a markedly limited use of social greetings. Eaves and Ho (1996) reported results of a longitudinal study conducted with 76 children with ASDs, of whom approximately 33% had HFA. Over four years, progressing from a mean of 7;06 years to 11;06 years, few gains were noted and "language and social characteristics changed little apart from general trends with age" (Eaves & Ho, 1996, p. 564). For example, the standardised score for receptive vocabulary remained more than 2 SD below the mean over time.

Howlin (2003) reported language levels of 34 young adults over the age of 18 years with HFA. While this study could not capture information on the entire HFA group due to use of measures with receptive and expressive age-equivalent ceilings of 18 and 19 years, respectively, results of 70% of the group were reported. Expressive vocabulary age equivalent scores for the 22 participants (who scored below the age ceiling) averaged 12 years behind chronological age. Receptive age-equivalent scores averaged 13 years behind chronological age. Howlin, Goode, Hutton and Rutter (2004) reported that low receptive language levels remained in 68 adults with ASDs, the majority of whom had HFA (mean 29 years) and who had originally been assessed at a mean chronological age of 7 years. Ultimately, the group achieved a mean age-equivalent of 8 years on the British Picture Vocabulary Scale (BPVS) whilst almost half the group were not able to score above the basal level.

2.1.1.20 Summary of Reported Language Abilities in HFA

It is difficult to draw definitive conclusions about overall language abilities in children with HFA because of problems in teasing out specific abilities from studies that have not clearly or consistently differentiated between those with HFA and those with impaired cognitive skills. Additionally, many previous studies have used relatively small groups of participants, making it difficult to replicate findings or to generalise results across the heterogeneous individuals with HFA. However, findings indicate that many children with HFA show impairment in receptive and expressive language skills, while pragmatic skills are consistently impaired. Articulation and phonological skills, while not universally intact, are not as impaired as other language skills. Findings are unclear about semantic abilities but anecdotal evidence lends support that higher-level abstract meanings are most problematic. Overall, results from recent outcome studies reported variable findings which ranged from stagnation of language skill development to continued but delayed growth that follows typical developmental trends. Finally, abilities across children with HFA are notable for the great individual variation in all areas.

2.1.2 Non-Verbal Cognitive Skills

2.1.2.1 Rationale for Non-Verbal Assessment of Cognitive Ability

Children with HFA have, by definition, non-verbal cognitive skills within the normal range (Baltaxe and Simmons, 1992; Tsai, 1992; Waterhouse, 1996; Gillberg & Ehlers, 1998; Szatmari et al., 2003; Howlin, 2003; Starr et al., 2003; Klin et al., 2005; Landa & Goldberg, 2005) whilst also presenting a history of a language delay which makes it likely that verbal IQ will not be within the normal range (Fombonne, 2003; Fombonne, 2005; Volkmar et al., 2004). Additionally, there is evidence that some children with HFA have a discrepancy between non-verbal cognitive skills and language ability (Tager-Flusberg, 2004). Therefore, assessment of non-verbal cognitive skills "provide an accurate assessment of the individual's true level of intellectual functioning…by reduc[ing] the bias associated with influences of language" (McCallum, Bracken & Wasserman, 2001, p. 4).

2.1.2.2 Non-Verbal Cognitive Skills in Children with HFA

A number of studies indicate that cognitive abilities in children with ASDs/HFA continue to change during early childhood (Lord & Schopler, 1989) and from early childhood to adolescence (Sigman & McGovern, 2005). Sigman and Ruskin (1999) reported stability in IQ over 9 years in a group of children with ASDs with a much wider IQ range, including those with very low scores as well as those with HFA, yet noted that there was a great amount of individual variability. In a more recent study of the same group of individuals with ASDs, Sigman and McGovern (2005) reported a significant decline in cognitive skills during the period from middle childhood to early adolescence with less change in these skills during early to late adolescence. However, these reports probably reflect the fact that the group included children with a broad range of IQ ability.

Other longitudinal research of individuals with ASD indicates that non-verbal cognitive skills do not increase appreciably. Particularly in individuals with HFA, non-verbal cognitive skills remain generally stable over time, although there is a great deal of individual variation (Lord & Schopler, 1989; Lord & Venter, 1992; Venter et al., 1992; Nordin & Gillberg, 1998; Starr et al., 2003). Howlin et al. (2004) reported on a group of children and adults with ASDs who had initial IQs over 50 and found that non-verbal IQ scores remained fairly stable from early childhood through adulthood. Eaves and Ho (1996) also found stability over four years in pre-adolescent children with HFA. Several researchers have noted that the children with ASDs/HFA who start off with better cognitive skills are more likely to have greater change in a positive direction (Rutter, 1970; Mayes & Calhoun, 2003; Billstedt, Gillberg & Gillberg, 2005). Therefore, results indicate that children with non-verbal cognitive skills in the normal range such as those with HFA tend to have stable scores over time, as do children with typical development (Raven, Court & Raven, 1986; Mackintosh, 1998; Raven, 2000).

2.2 PROSODY

As discussed in Chapter 1, the definition of prosody and its features is variable across the literature (Couper-Kuhlen, 1986; Vihman, 1996; Cruttenden, 1997; Crystal, 1986) such that no one definitive list of prosodic features exists (Fox, 2000). For the purposes of the current study, prosodic features are those supra-segmental changes in loudness, duration, pitch and pause time that affect grammatical, pragmatic and emotional functions, but will exclude parameters of fluency/dysfluency, voice quality, vocal reflexes (Couper-Kuhlen, 1986), articulatory settings and indexical functions such as membership in different age-groups, sex-groups, or socio-regional groups (Couper-Kuhlen, 1986). McCann and Peppé (2003) used a similar functional approach in their critical review of literature studies investigating prosodic abilities in children with ASDs, with the rationale that such an approach was used in the majority of the studies they examined. In the following section the features of prosody will be examined, followed by a consideration of assessment options, a brief overview of prosodic development in typically developing children and then a review of findings on prosodic ability in children with HFA.

2.2.1 Prosodic Features

2.2.1.1 Stress

Speakers use a change in pitch, duration and/or intensity to effectively signal accent or stress (Baltaxe & Simmons, 1985; Couper-Kuhlen, 1986). English is a stress-timed language and listeners are helped to comprehend a sentence by being able to predict the location of upcoming accents, thus are directed to the potentially most salient portion of an utterance (Baltaxe & Simmons, 1985). For example, in English, the use of heavy stress on a word or phrase indicates it is the focus of the utterance (Solan, 1980).

McCann and Peppé (2003) provided a succinct explanation of this rather complex prosodic feature, noting that sentential stress refers to the idea that all complete utterances include either a stressed syllable or word; if there is no portion of the utterance with more substantive meaning than another, then the utterance is said to be in broad focus and the stress is considered default stress. Alternatively, if the speaker means to indicate that one part of an utterance has greater importance, it is said to be in narrow focus and the stress is referred to as contrastive stress, which highlights new or clarified information from a previous utterance (McCann & Peppé, 2003; Halliday, 1970). The listener needs to note where contrastive stress occurs to fully understand the communicative intent of the speaker. Thus, contrastive stress serves a pragmatic function (Baltaxe, 1984; McCann & Peppé, 2003).

2.2.1.2 Intonation

Cruttenden (1997) described intonation as a prosodic feature that usually applies to multi-word utterances such as phrases or sentences, whilst pointing out that either may only consist of a single word. Intonation is comprised of falling and rising pitch contours of which there are countless combinations; Halliday (1970) asserted that generalities about the meanings of so many possible contours are difficult to make but offered that a falling contour usually indicates certainty and a rising contour usually indicates uncertainty. Thus, the use of a falling tone usually indicates the speaker has ended his/her turn, while a rising tone at the end of an utterance indicates the speaker is waiting for a response; however a 'wh' question also uses a falling tone and does require a response (Halliday, 1970). McCann and Peppé (2003) asserted that intonation serves both grammatical and pragmatic functions.

2.2.1.3 Chunking

McCann and Peppé (2003) used the term chunking to describe the use of pause, stress, intonation and duration to signal boundaries in phrasing. However, chunking excludes rate, word repetitions and revisions, features which are specific to lexical information and speech fluency. Prosodic chunking serves a grammatical function by the presence or absence of pauses and use of syllable lengthening which clarifies otherwise syntactically ambiguous spoken utterances such as 'We need chocolate milk and bread' where it could be unclear whether both chocolate and milk are needed (two separate items) or whether the speaker is requesting chocolate-milk as a single item. In this example, to denote chocolate and milk as two separate items, there is a longer pause between the words chocolate and milk as well as a lengthening of the final syllable in the word chocolate to differentiate it as a single item which is separate from milk.

2.2.1.4 Affect

Prosody, by way of changes in intonation, pitch range, intensity and speech rate across an entire utterance, can also signal the speaker's mood, attitude or emotional state; although Baltaxe and Simmons (1985) noted that it is unclear exactly how acoustic cues combine to guide the listener to make an inference about an emotional state. However, intonation has a critical role in the expression of attitude and emotions (Couper-Kuhlen, 1986). For example, McCann and Peppé (2003) reported that generally an utterance with a wide, high pitch range will suggest to the listener that the speaker has a positive affect; alternatively use of a narrower and lower pitch range will usually suggest the speaker has a negative attitude or affect.

2.2.2 Assessment of Prosody

While there is a wealth of information about the developmental progression of the major aspects of language in typically developing children, the area of prosody has not yet been comprehensively examined across the lifespan. Much of the research on prosodic development has been undertaken in studies of infants and toddlers, with a paucity of information about changes that take place in the school age years (Crystal, 1986; Wells et al., 2004). The study of prosody can include its reception and expression, as well as specific aspects such as the aforementioned accent/stress, affect and intonation, and grammatical/pragmatic distinctions; however in the research literature, frequently only a few of these aspects are measured in a single study (McCann & Peppé, 2003). Additionally, prosodic ability has been infrequently investigated in children with speech and language impairments (Wells & Peppé, 2003), such as those with ASDs/HFA. Of the studies that have examined prosody in children with ASDs, the main focus has been on expressive rather than receptive prosody skills. In a review of studies on prosodic skills in children with ASDs, McCann and Peppé (2003) noted only two published studies at that time had examined receptive understanding.

Prosody assessment measures are variable depending on a particular author/researcher's working definition and interpretation of what constitutes prosody. Therefore various assessment tools differ in terms of the areas they consider to be in the domain of prosody. For example, voice quality measures such as hoarseness, harshness and nasality are measured in the Prosody-Voice Screening Profile (Shriberg, Kwiatkowski & Rasmussen, 1990) and Vocal Profile Analysis (Laver, Wirz, Mackenzie & Hiller, 1981), but not in Profiling Elements of Prosodic Systems-Children (Peppé, McCann & Gibbon, 2004). Several prosody assessment tools are checklists or summaries of features present or absent in conversational speech, thus providing the advantage of evaluating prosodic abilities and disabilities as they occur in more naturalistic and functional occurrences (e.g., Prosody-Voice Screening Profile (Shriberg et al., 1990); Vocal Profile Analysis (Laver et al., 1981); Profile of Prosody (Crystal, 1982)). Other prosody assessment tools use structured tasks in which the stimuli are determined by the test (e.g., Phonological Evaluation and Transcription of Audio-Visual

Language (Parker, 1999); Tennessee Test of Rhythm and Intonational Patterns (Koike & Asp, 1981); Profiling Elements of Prosodic Systems-Children (Peppé et al., 2004)). Structured assessments have the advantage of assessing a range of prosodic features and comparing results on the similar tasks across participants. All the assessments listed above share a disadvantage; none provide normative data within the test manuals with which to compare results, although the Profile of Prosody (Crystal, 1982) provides general age ranges and guidelines of normal development of prosodic ability. Additionally, Peppé, McCann, Gibbon, O'Hare and Rutherford (in press) reported normative data gathered from 72 typically developing children (mean 6;10 years) on the Profiling Elements of Prosodic Systems-Children (Peppé et al., 2004) and Shriberg et al. (2001) reported normative data from 53 individuals with typical development ranging in age from 10 to 50 years (mean 20;09 years) on the Prosody-Voice Screening Profile (Shriberg et al., 1990).

2.2.2.1 Perceptual Judgments

An important challenge in the assessment of expressive prosody is the fact that many of the results are determined by listener or rater judgments, as opposed to use of measurable information which might be gleaned from acoustic or other types of instrumental analyses. Duffy (2005) noted the challenges with perceptual judgements, whilst acknowledging their importance, stating:

> "Perceptual methods are based primarily on the auditory-perceptual attributes of speech. *They are the "gold standard" for clinical differential diagnosis, judgments of severity, many decisions about management, and the assessment of functional change.* At the same time, they are subject to unreliability of judgments among clinicians, they may be difficult to quantify, and they cannot directly test hypotheses about the pathophysiology underlying perceived speech abnormalities. In the hands (ears, eyes, and hands, actually) of experienced clinicians, however, the auditory-perceptual classification of Motor Speech Disorders is a valid and essential diagnostic and clinical decision-making tool. It is unlikely that it will be replaced by other methods, however sophisticated, because the evaluation of a speech disorder always begins with a perceptual judgment that speech has changed or is abnormal or different in some way" (p. 9).

However, the study of prosody has benefited from development of more refined speech analysis tools, thus allowing greater detail and precision of measurement which can potentially verify perceptual data (Baltaxe & Simmons, 1985). Nonetheless, Hargrove and McGarr (1994) cautioned that instrumental measures of acoustic parameters such as fundamental frequency, duration or amplitude each reflect only a single aspect of prosody, thus do not directly correlate with the overall prosodic information as received by the listener. For example, "in connected speech, one may "hear" a rising pitch direction but see it on an instrument … as a *decrease* in frequency, an *increase* in amplitude, and an *increase* in duration" (Rubin-Spitz & McGarr, 1990, p. 4).

2.2.3 Prosody Skills in Children with Typical Development

After reviewing studies of prosodic development in typically developing children, Baltaxe and Simmons (1985) concluded that prosodic abilities exceed phonological, syntactic and semantic skills in the early stages of development. Typical infants develop the ability to encode and remember patterns of prosodic cues from their native language (Gerken & McGregor, 1998) and benefit from exaggerated intonational contours often used by parents or care providers to enhance language comprehension (Garnica, 1977). They use increasingly varied vocalisations by six months (Crystal, 1986) and overall control of pitch increases and stabilises by 12 months (Vihman, 1996). By 24 to 36 months, most children are using default stress on the ends of utterances and begin to manipulate stress or accent for emphasis and contrast (Crystal, 1986; McCann & Peppé, 2003). Receptively, stress has been found to greatly assist in memory of verbal information (Baltaxe & Simmons, 1985). By the age of five years, children can use pitch and duration cues to guide grammatical interpretation, begin to use affective intonation to indicate likes and dislikes and have acquired the ability to use pauses within phrases to indicate meaning (Wells et al., 2004). More refined skills for using and understanding prosodic features continue to develop and are well in place by 11 to 12 years of age (Atkinson-King, 1973; Wells et al., 2004), however even some adults may not have consistent use of some features (Wells et al., 2004).

2.2.4 Prosody Skills in Children with HFA

2.2.4.1 Expressive Prosody Skills in Functional Communication

In their seminal publications, both Kanner (1943/1985) and Asperger (1944/1991) observed that the verbal utterances of some of the children they simultaneously labelled autistic sounded monotonous or unusual. Hargrove (1997) noted that use of excessive and/or misassigned stress permeates the expressive prosody of many children with ASDs and ultimately gives "an exotic sound to speech" (p. 78). Simmons and Baltaxe (1975) reported unusual expressive prosody in 57% of the seven adolescents they assessed, whilst Shriberg et al. (2001) reported poor expressive prosody in 47% of 30 participants studied (as cited in Paul & Shriberg et al., 2005). Baltaxe and Simmons (1985) found that in children with ASDs, individual fundamental frequency ranges were at two ends of the extreme, either highly exaggerated or extremely narrow as compared to children with typical development matched by mean length of utterance. It has also been reported that expressive prosody, if atypical, continues to be so even when other communication abilities improve (Kanner 1971/1985; Baltaxe & Simmons, 1985; Rapin & Dunn, 2003).

2.2.4.2 Prosodic Stress in HFA

The majority of studies conducted on the expressive use of prosody in children with ASDs have investigated the prosodic feature stress. Baltaxe (1984) assessed the use of contrastive stress in seven children with ASDs (mean 7;03 years, cognitive level not specified) and compared findings with a typically developing control group and an aphasic group (delayed language but normal non-verbal cognition) matched on mean length of utterance. The children with typical development assigned stress most accurately, followed by the aphasic group and then the children with ASDs. In addition, the children with ASDs tended to assign stress over more than one syllable whilst children in the control groups did not produce this type of error. In a related study using the same participants, Baltaxe and Guthrie (1987) used an elicited production task to assess the children's ability to produce primary/default sentence stress in utterances where "all stressable elements (content words) of that utterance carry an equal information load" (p. 257). Typically, default stress should occur on the end of the utterance. All three groups produced more incorrect than correct responses, with the typically developing children producing the most correct responses, followed by the aphasic group. The ASD group produced no correct responses. However, all groups misassigned stress in approximately 90% of all utterances to the subject position. Therefore, Baltaxe and Guthrie (1987) concluded there were more similarities than differences across groups on the use of default stress.

Fine, Bartolucci, Ginsberg and Szatmari (1991) assessed the use of default and contrastive stress within the conversational speech of 19 individuals with HFA (mean 22.8 years) and compared findings with a group of individuals with Asperger syndrome and a group of individuals who were psychiatric out-patients with social interaction difficulties. All individuals had full scale IQs over 70, although the mean IQ was highest for the outpatient group, followed by the Asperger and the HFA groups, respectively. All three groups used default stress appropriately; however the HFA group produced more stress on function words but comparatively little use of marked stress on the content words (Fine et al., 1991); thus the authors concluded that the individuals with HFA were not using stress in a communicatively functional manner. Shriberg et al. (2001) investigated the use of stress in 15 individuals with HFA (mean 21;08 years) comparing the results to 53 typical adult participants in the same age range using conversational speech samples that were coded using the Prosody-Voice Screening Profile (Shriberg et al., 1990). The group with HFA used stress appropriately in the majority of utterances (77% accuracy); however this was less accurate than the group of typical individuals and those with Asperger syndrome (95% and 87%, respectively). Examination of the type of stress errors produced revealed that the individuals with HFA most frequently misused contrastive stress, in the author's subjective judgment. The authors cautioned that inter-rater agreement for stress placement at the item level was marginally acceptable, with 14% agreement, while the overall agreement of 87% for the use of stress showed acceptable reliability (Shriberg et al., 2001).

Two recent studies assessed both expressive and receptive use of prosodic stress in individuals with HFA. Paul, Augustyn, Klin and Volkmar (2005) conducted a study with 27 adolescents and young adults with ASDs (14 of these individuals were noted to have HFA and all participants had IQs greater than 70 (mean 16;10 years)) and 13 typical individuals in the same age range (mean 16;09 years). The authors assessed the understanding and use of lexical stress (e.g. **re**call (noun) vs. re**call** (verb)) as well as contrastive stress, finding that the ASDs/HFA group performed significantly worse on production of lexical stress, as well as on the understanding and production of contrastive stress. Peppé et al. (in press) reported results of a study of prosodic ability in which 31 children with HFA (mean 9;09 years) and 72 typically developing children (mean 6;10 years) were matched on verbal mental age. This study assessed prosodic ability via the computerised version of Profiling Elements of Prosodic Systems-Children (PEPS-C) (Peppé et al., 2004), including the understanding and use of contrastive stress. The children with HFA performed significantly worse than the typically developing children on both receptive and expressive tasks, thus confirming the findings of Paul et al. (2005). In both studies, similarly high mean inter-rater agreement levels were reported for the expressive tasks (Paul et al., 2005 - 90%; Peppé et al., in press - 88.6%).

Overall, findings have consistently reported the understanding and use of contrastive stress to be significantly worse in individuals with HFA as compared to those with typical development.

2.2.4.3 Intonation in HFA

Kanner (1943/1985) noted that several of the children with HFA in his study were able to imitate the intonation patterns of their communication partners. For example, he reported, "if the mother's original remark has been made in the form of a question, it is reproduced with the grammatical form and the inflection of a question" (Kanner 1943/1985, p. 43). Paccia and Curcio (1982) conducted an investigation of the echolalic utterances of five children with ASDs (mean 11;06 years) and found that, although 54% of the utterances did imitate the adult speaker's prosodic contours in questions, the remaining utterances were altered and became "prosodically contrastive" (p. 45). Thus an utterance with rising tone at the end was produced with a falling tone. This investigation used both subjective judgments and fundamental frequency plots to confirm the contours of the utterances. Findings were statistically significant; the contrastive utterances were most likely to occur when echoing a question that required a 'yes' response to be correct, thus the alteration of the prosodic contour served the function of responding. The authors suggested that the children who did not alter prosodic contours demonstrated greater linguistic impairment than those who were able to manipulate the intonation patterns.

Paul et al. (2005) investigated understanding and use of intonation for grammatical and pragmatic functions in 27 adolescents and young adults with ASDs (14 had HFA) and 13 typically developing individuals in the same age range (mean 16;09 years). Grammatical intonation was assessed through identifying and producing intonation to indicate either questioning or stating. The receptive tasks required the participant to listen to a recorded narrative on which a sentence was produced with a rising intonation to indicate a question or a falling intonation to mark a statement and then indicate either 'asking' or 'telling' on a response sheet. Expressively, the participant was instructed to read a sentence in a manner that was 'asking' or 'telling'. Pragmatic intonation was assessed receptively by instructing the participant to identify presence or absence of 'motherese' by pointing to a picture of either a baby or an adult as the person to whom the narrator was speaking. Expressively, the participant was told to read a sentence as she/he would to the person pictured next to the sentence (either a baby or adult). There were no significant difference on any of these four tasks between the ASDs/HFA and control groups, as all groups performed at close to 100% accuracy. Thus Paul et al. (2005) stated that ceiling effects limited the conclusions that could be made.

Peppé et al. (in press) assessed intonation ability in several ways both receptively and expressively in 31 children with HFA (mean 9;09 years) and 72 typically developing controls. Similar to the Paul et al. (2005) study, they assessed grammatical intonation through the understanding and use of rising or falling intonation to differentiate between questions and statements; however they assessed it via single words rather than in sentences using the computerised PEPS-C programme. For the receptive task, a recorded narrative named a food using either a rising tone to indicate questioning, or a falling tone to indicate labelling. The auditory stimulus was played whilst the computer screen showed a picture of a person holding the food on a plate with a large question mark. This was shown on one side of the computer (the child was told the person was asking if the listener wanted the food item), whilst on the other side of the computer screen the food was pictured with a person holding a book (the child was told the person was naming the item, as though it was being labelled). The child was instructed to point to the picture that matched the voice. For the expressive tasks, one of these picture options would appear individually and the child was instructed to say the name of the food either in an 'asking' or 'telling' way, depending on the picture that appeared. There was a significant difference between the children with HFA and the control group on both the receptive and expressive tasks. Receptively, a higher percentage of children with HFA judged all the questioning stimuli as statements (13% compared to 3% of the controls). The expressive tasks revealed the prosody of the children with HFA was significantly more likely than that of the controls to be judged as ambiguous, thus the listener was not able to reliably judge the communicative intent (Peppé et al., in press).

Therefore studies indicate use of prosodic contours is another area of difficulty in children with HFA. Expressively, their use of intonation does not reliably match the communicative intent, or is used functionally, but unconventionally. The limited information on the ability of children with HFA to understand contours in single words that differentiate between stating and questioning indicates this is an area of difficulty but more information on this area is needed.

2.2.4.4 Chunking in HFA

There are only a few studies which have reported on chunking or phrasing abilities in individuals with HFA. Fine et al. (1991) reported their group of 19 individuals with HFA (mean 22.8 years) were as able to signal the ends of phrases within the conversational speech as a group with Asperger syndrome and a group of psychiatric inpatients with social difficulties. Paul et al. (2005) assessed receptive and expressive chunking ability within phrases in 27 individuals with ASDs (14 with HFA). For the receptive task, the participant heard a recorded narrative of a sentence, then indicated if the chunking was understood by reading a question about the narrative (e.g., if the narrator says 'Ellen, the dentist, is here' the participant should answer 'no' to the question that reads 'Is she talking to Ellen?'). For the expressive task, the participant heard a recorded narrative that provided information to indicate a fact that would affect how the participant chose to 'chunk' a sentence (e.g., if Ellen is known to be a dentist, the participant would then need to read the sentence 'Ellen the dentist is here' as 'Ellen, the dentist, is here'). On both receptive and expressive tasks, the individuals with ASDs/HFA did not differ statistically from the group with Asperger syndrome or those with typical development. However, the authors noted that participants within all groups performed close to 100% on both tasks. Therefore Paul et al. (2005) concluded that ceiling effects may have masked differences that would probably emerge in more difficult tasks.

Peppé et al. (in press) assessed receptive and expressive chunking abilities through tasks which presented two pictures of groups of items. For the receptive tasks, the child was asked to listen to a recorded narrative and decide which of the two pictures best represented the phrase she/he heard (e.g., if the child heard 'chocolate, cake and buns' then she/he should choose the picture of these three individual items and ignore the picture of two items (chocolate-cake and buns)). For the expressive task, a picture appeared on the computer screen and the child named what she/he saw while the examiner makes a judgment on where the first pause occurred (e.g., if shown the picture of chocolate-cake and buns (2 items), the child should use a longer pause after cake). The HFA group were significantly worse than typically developing children on the receptive task but there was no difference noted on the expressive task, with both groups performing below a pre-determined competency level.

Overall findings on expressive chunking/phrasing have been inconclusive between children with typical development and those with HFA; however children with HFA were more impaired than controls in receptively differentiating between phrases based on prosodic boundaries.

2.2.4.5 Affect in HFA

The ability with which individuals with HFA are able to understand and/or produce affect competently was discussed anecdotally by Asperger (1944/1991), who noted that the children in his study had difficulty understanding the emotional affect in the voices of those around them. There are very few studies that have investigated understanding and expression of affect in children with HFA; although several studies have investigated the ability to match facial and vocal/prosodic expressions (Boucher, Lewis & Collis, 1998; Hobson, Ouston & Lee, 1988; Lindner & Rosén, in press).

Rutherford et al. (2002) assessed the ability to perceive affect from vocalisations (including parameters of voice and prosody) in order to make judgments about the speaker's mental state in 19 adults with HFA and Asperger syndrome (mean 29 years) and 78 typical adults matched on verbal IQ. The stimuli were phrase or sentence length material taken from dramatic performances on audiotape. The participants were required to listen to a segment and then circle the written word that best described the mental state of the speaker (e.g., stimulus - 'No, honestly I do'- earnest (correct mental state)- alarmed (incorrect mental state)). Participants were given a chance prior to testing to review the list of words and given the opportunity to say if there were any words that were not understood. The individuals with HFA and Asperger syndrome performed significantly worse than controls on this task. The authors concluded that affective vocalisations are an outwardly perceptible expression of theory of mind. However, McCann and Peppé (2003) suggested that methodological drawbacks in the Rutherford et al. (2002) study limited the conclusions that could be drawn; specifically the fact that some of the stimulus items had inherent semantic cues which would lead the responder toward a certain response, as opposed to having to rely on the prosodic information. For example, the item "I'm afraid he's gone out, sir" semantically prompts the listener to understand the correct response would be 'apologetic' rather than 'hurried' (the other response choice provided). Further, given that semantic understanding may be impaired (Tager-Flusberg, 1981; Boucher, 2003), it may be that a poor score was more reflective of a semantic, rather than prosodic deficit, or a combination of the two.

Paul et al. (2005) assessed reception and production of affect in phrases in 27 individuals with ASDs (14 with HFA) in which the receptive task required the participant to judge if a recorded narrative was spoken by a calm or excited speaker and then indicate their choice by pointing to a picture of a facial expression symbolising one emotion or the other. The expressive task required the participant to read a sentence in a calm or excited manner to reflect the mood of a person on a picture presented with the sentence. Results were again hampered by ceiling effects and no significant differences in either the understanding or expression of affect were apparent across groups. However, the authors noted that the ASDs/HFA group appeared to use a rapid rate of speech to produce an excited affect and used a slow rate to produce a calm affect. Further the authors added that although the productions were correct to the blind rater, they "lacked, subjectively, some portion of the affective quality of excitement, beyond the rapid rate" (Paul et al., 2005, p. 214).

Peppé et al. (in press) assessed understanding and production of affect through tasks requiring participants to identify or produce affect that indicated 'like' or 'dislike' of food items in 31 children with HFA (mean 9;09 years). For the receptive task, a recorded narrative named a food item using either a positive or negative affect; the narrative was presented while the child was simultaneously shown a picture of a smiling face (to indicate liking) on one side of the computer and a frowning face (to indicate dislike) on the other. The child was instructed to point to the face that matched the voice. For the expressive task, the child was shown individual pictures of food items and told to name the food so the examiner could tell if the child did or did not like it. The HFA group performed significantly worse than the control group on both the receptive and the expressive tasks. Peppé et al. (in press) noted that receptively, the children were "inclined to judge input stimuli according to their own preferences" (p. 22) but did not clarify their evidence for this supposition. Additionally, the affect task in the PEPS-C is also a face and affect matching paradigm. Children were not pre-tested on their ability to distinguish between the happy and sad faces (although they were pre-tested on knowledge on the other items on the test; e.g., same vs. different symbols, individual vocabulary items). There is evidence that children with ASDS/HFA are indifferent to facial expression (Kanner (1943/1985) and impaired in their ability to match facial expressions to verbal expressions of emotion as compared to mental-age matched controls (Hobson, 1986; Hobson et al., 1988; Boucher et al., 1998). Therefore, poor performance on this task could be reflective of, or exacerbated by, possible deficits in ability to understand facial expressions.

Lindner & Rosén (in press) investigated the ability of children with Asperger syndrome (mean 10;03 years) to decode emotion through facial expressions, prosody, and semantic content, individually and in combination, and compared findings to chronological age-matched typically developing children. The prosody content task used audio recordings of neutral semantic content with "various vocal inflections to indicate the emotion" (Linder & Rosén, in press, p. 4). The children with Asperger syndrome performed significantly worse than the control group at correctly identifying emotions (e.g., happy, sad, angry, neutral) from static facial expressions, dynamic facial expression (in video clips) and prosody when these facets were assessed individually. However, there was no significant difference in group performance on decoding emotions through semantic information (when only the written content was presented) or when the stimuli from combined modalities was assessed. The authors concluded that reliance on strong language skills, which are typical of children with Asperger syndrome (World Health Organization, 1992; American Psychiatric Association, 1994; Szatmari, 1998), is a compensatory strategy used to understand emotion. Although this study did not assess children with HFA, it is reasonable to assume that children with HFA, due to their poorer language skills, would not have a linguistic strategy to rely on and would therefore perform poorly on a similar task. However, this would need to be confirmed empirically.

A recent study by Hubbard and Trauner (in press) assessed the range of pitch used by nine children with ASDs, nine with Asperger syndrome and ten with typical development (mean 14.5 years). The individual was instructed to repeat phrases from tape recordings in which five linguistically neutral phrases were presented three times, once with happy affect, once with sad affect and once with angry affect. Using acoustic analysis, all three groups showed the same pattern of mean pitch range to mark emotion, with happy showing the widest range, followed by angry and then sad. The group with ASDs had the widest mean pitch ranges overall for every emotion. A second experiment then coded subjective judgments of the repetitions and revealed that the individuals with ASDs were significantly worse at encoding the targeted emotion. The same study also assessed the groups on a spontaneous speech task, first measuring pitch range (as with the repetition task) and then used subjective judgments of raters to code the utterances. For the spontaneous task, the child was told to complete a short story that was read by the examiner with a single sentence whilst pretending to be one of the characters. The stories were designed to elicit a clear response of happy, sad or angry. Although four of nine children with ASDs were unable to complete this task, all groups again showed the same pattern of wide to narrow mean pitch range to indicate emotion (happy, angry, sad). The subjective ratings revealed the same results as the repetition task, with the children with ASDs performing significantly worse than either of the other two groups (Hubbard & Trauner, in press). This is an interesting study which usefully combines acoustic and perceptual data, however it has some drawbacks. The authors did not provide information about non-verbal skill level, so it is unclear whether or not the children with ASDs had HFA. No information was provided about the language abilities or age-equivalents of any group and most problematic was the lack of information about if or how the groups were matched (e.g., language ability, chronological age). Additionally, the spontaneous task would require some ToM ability to speak from the perspective of a character in the story; this may explain why some children could not complete the task and may have affected the performance of those who did complete it.

In sum, investigations about the understanding and use of prosody for affective/emotional functions in children with HFA/ASDs provide evidence that it is functionally impaired. However, further studies which separate out some of the possible confounding factors (e.g., face processing, semantic ability, ToM) with clearly defined groups of children with HFA are needed.

2.2.4.6 Prosodic Ability in Imitation Tasks

Peppé et al. (in press) also investigated the ability of 31 children with HFA (mean 9;09 years) and 72 typically developing children matched on verbal mental age to identify differences in intonation patterns in single words and in phrases as well as to imitate a variety of patterns, outside of functional context. In the perception task, the stimuli were presented via laryngograph recordings; therefore only the intonational contour was heard. To the listener, laryngograph recordings sound like humming or buzzing, similar to hearing speech in an adjacent room where the content of the message is unintelligible (Peppé et al., in press). The receptive task required the participant to listen to two sounds and decide if they were the same or different and then to indicate this by pointing to a picture symbolising 'same' on one side of the computer screen or to a picture symbolising 'different' on the other. For the expressive task, the participant was told to imitate the word or phrase spoken by the recorded narrator and the examiner made a judgment as to how closely the imitated word or phrase matched the contour and intended function of the stimulus. The children with HFA performed significantly worse on both the receptive and expressive tasks than the typically developing children. The authors noted that the HFA group produced deviant error patterns such as judging two of the same items as different. This type of error was not seen in the typically developing children. Additionally, Peppé et al. (in press) stated that poor performance on imitation tasks was contrary to the "widely reported ability [of children with HFA] to repeat large parts of their favourite videos, verbatim and in the appropriate accent" (p. 23) and suggested that motivation for the tasks may have affected imitation abilities.

2.2.4.7 Correlations between Prosody, Chronological Age and Verbal Mental Age

Peppé et al. (in press) examined relationships between results of the PEPS-C and chronological and verbal mental-age in 31 children with HFA (mean 9;09 years) and 72 verbal mental age-matched controls with typical development. They found both the receptive and expressive prosody tasks correlated highly with chronological age and verbal mental-age in the control group, whilst only the receptive prosody scores correlated significantly with chronological and verbal mental-age in the children with HFA.

2.2.4.8 Correlations between Prosody, Language and Non-Verbal Cognition

McCann et al. (in press) examined relationships between results of the PEPS-C and measures of language ability in 31 children with HFA (mean 9;09 years), finding that the combined receptive and expressive prosody scores correlated highly with measures of receptive grammar, receptive vocabulary and expressive language. Only the receptive prosody tasks showed a significant correlation with non-verbal cognitive skills. There was no correlation between single word articulation skills and prosodic ability.

2.2.4.9 Correlations between Prosody and Pragmatics

Paul and Shriberg et al. (2005) reviewed the findings from the Shriberg et al. (2001) investigation of voice and prosody in 15 individuals with HFA (mean 21;08 years), which compared results to 53 typical adult participants in the same age range using conversational speech samples that were coded using the Prosody-Voice Screening Profile (Shriberg et al., 1990). Paul and Shriberg et al. (2005) found that the HFA group produced more instances of inappropriate stress assignment as compared to the control group and that the amount of inappropriate stress approached significance as a predictor of socialisation ratings on the Vineland Adaptive Behavior Scales (Sparrow, Balla & Cicchetti, 1984). Additionally, the use of inappropriate stress assignment was significantly correlated to the Communication score of the Autism Diagnostic Observation Schedule-Generic (Lord et al., 2000). However, there were no significant correlations between verbal ability and percentage of inappropriate stress or percentage of inappropriate phrasing in the HFA group.

2.2.4.10 Longitudinal Findings of Prosodic Skills in HFA

To date there have been no published longitudinal studies of receptive or expressive prosodic skills in children with HFA. However, Peppé et al. (in press) concluded that results of their study of receptive and expressive prosodic ability in 31 children with HFA was more indicative of an overall delay in abilities rather than deviance; however the authors did find examples of error patterns not found in their control group of typically developing children. Therefore, they may have made premature conclusions concerning the possible progression these skills might take over time given the aforementioned equivocal results.

2.3 THEORY OF MIND

Theory of mind (ToM) represents a flourishing area of research, particularly in regards to the presence, delay or impairment of abilities in individuals with ASDs. Deficits in ToM have been interpreted as reflecting core impairments leading to commonly observed behaviours in those with ASDs (Baron-Cohen et al., 1985; Tager-Flusberg, 2000a). As discussed in Chapter 1, ToM is defined as the ability to attribute thoughts, feelings and ideas to others, to conceptualise a relationship between oneself and others, and the ability to use this knowledge to predict others' behaviour (Baron-Cohen, 1995; Baron-Cohen, 2000; Bibby & McDonald, 2005) such that socially competent behaviour is dependent on it (Wellman, 1990). In the following sections, a brief overview of ToM skills in typically developing children will be provided followed by an overview of measures used to assess ToM. A review of findings from studies which have assessed ToM in individuals with HFA will then be presented.

2.3.1 Assessment Tools

Currently, there are no standardised assessments of ToM, although some tasks, or groups of tasks, have a considerable amount of data regarding the ages at which typically developing children are able to succeed. False-belief tasks have been the most frequently used assessment (Wimmer & Perner, 1983; Bartsch & Wellman, 1995; Wellman, Cross & Watson, 2001; Hale & Tager-Flusberg, 2003) and have been presented in a variety of ways. As described in Chapter 1, a false-belief task can be presented by showing a highly familiar container (e.g., pencil box, Smarties tube, plaster box) to the child, having the child guess what is inside, revealing the unexpected contents, and then asking the child to guess what another person (who was not in the room when the real contents were revealed) would think is in the container. Alternatively, false-belief understanding may be assessed by presenting a story to the child in which one character knows something to be a fact and then, unbeknownst to this character, another character changes something. To demonstrate an understanding of false-belief, the child needs to know that the first character will act based on something which is no longer true, thus a false-belief (Baron-Cohen et al., 1985; Perner, Leekham & Wimmer, 1987). A meta-analysis by Wellman et al. (2001) demonstrated that researchers have adapted the task by using or eliminating repeated questioning (e.g., "what do you think is in here?" and "what is really in here?"), using or eliminating temporal marking (e.g., "where will Maxi look for his chocolate?" vs. "where will Maxi look *first* for his chocolate?") and through a variety of presentation methods (e.g., puppets, storybook pictures, adults as actors, video).

Second-order tasks have been presented in a variety of ways also (Perner & Wimmer, 1985; Baron-Cohen, 1989; Bauminger & Kasari, 1999; Silliman et al., 2003). However the basic premise is that the child must synthesise multiple perspectives about what two characters are thinking in a situation where the conflicting beliefs of the characters are only known to the child (Silliman et al., 2003). For example, Perner and Wimmer (1985) devised a task known as the John & Mary or Ice-cream Van task. The child learns that two children (John and Mary) are in a park when an ice-cream van appears; John says he doesn't have any money, but the ice-cream man tells John not to worry because he'll be at the park all day. John leaves to go to his home to get money to buy ice-cream and after he leaves, the ice-cream man tells Mary that he is going to drive to the church to sell ice-cream there. The ice-cream man drives off and while on his way to the church he passes John's house, sees John, and tells him he is going to be selling ice-cream at the church. Meanwhile Mary (who does not know the ice-cream man has spoken to John) goes to John's house, where John's mother tells her John has gone to buy an ice-cream. The child is asked to tell where Mary thinks John will go to buy his ice-cream and why. In order to fully demonstrate second-order ToM ability, the child needs to be able to say that Mary thinks John will go to the park because John thinks the ice-cream man was going to be there all day. Most investigations also use control questions throughout the story to be sure the child has been able to follow all the details. Other second-order tasks have been devised particularly for a single investigation, thus there is a great deal of variability across studies.

Two measures provide a more comprehensive assessment of ToM ability while tapping abilities at different levels on the developmental spectrum. Wellman and Liu (2004) adapted several individual tasks from earlier research studies to create a scale which, following analyses by both Guttman and Rasch models, was deemed a reliable tool on which five individual tasks represent increasingly sophisticated understandings of ToM. From easiest to most difficult, the tasks assess: 1) understanding two people can have different desires, 2) understanding different people may have two different guesses about where something may be hidden, 3) understanding that a person can not really know what is inside a container without being able to see inside it, 4) false-belief (using an expected contents task) and 5) understanding that a person can feel one emotion while trying to display a different emotion (e.g., feeling sad but trying to look happy). Most typically developing children by the age of 6 years are able to pass all tasks on the scale (Wellman & Liu, 2004).

Happé (1994) developed a set of tasks, called 'Strange Stories', to assess more sophisticated and subtle ToM abilities that generally develop after eight years of age in typically developing children. These tasks assess the understanding of lies, white lies, situational misunderstanding, sarcasm, persuasion, contrary emotions, pretending, jokes, figures of speech, double bluff and forgetting, using brief stories that are read aloud. The child is asked questions after each story and receives a score for understanding if something is true or false, earning a variable score depending on the rationale he/she provides for their answer (1 point for an answer that provides information about a physical state, 2 points for an answer that provides information about a psychological state, 3 points for a full answer that combines knowledge from the physical and psychological state).

Assessing ToM in more naturalistic tasks has also been conducted in response to the criticism that ToM knowledge may not be completely predicted by performance on contrived tasks (Kremer-Sadlik, 2004). For example, using conversational samples and video recorded interactions can yield data beyond a simple pass or fail. Instead, such a method allows more descriptive information about how children understand and use perspective taking ability while talking with familiar listeners about familiar topics; thus revealing more about the functionality of ToM in children (Kremer-Sadlik, 2004; Dunn & Brophy, 2005; Harris, 2005).

2.3.2 Theory of Mind Skills in Children with Typical Development

Empirical evidence has indicated that ToM is not an all-or-none phenomenon; rather it is a gradual progression of abilities that eventually combine into a mature and sophisticated understanding of others' thoughts and beliefs. (Meltzoff, Gopnik & Repacholi, 1999). This gradual development begins early; during the first year of life infants and their caregivers come to use a combination of vocalisations, postures and gestures to bring each other's attention to a particular object, activity or state and thus develop joint attention (Charman, 2006), an early ToM skill (Baron-Cohen, 1995). These behaviours indicate the emergence of the understanding of other persons as intentional beings (Carpenter, Nagell & Tomasello, 1998). By around 18 months of age, children are able to identify the referent of a new word using an adult's gaze direction or use of gestures (Owens, 2005), thus taking into account the intentions of that adult (Tomasello, 1995). Symbolic play also begins to appear by 18 months and "involves behaviorally treating an object as symbolizing something other than that which it is known to be or mentally representing it by decoupling it from its referent" (Yirmiya et al., 1998, p. 283). By two years of age, typically developing children demonstrate awareness that people experience different desires and emotions. At this age, children also begin to use words such as 'want' and 'like' (Carpendale & Lewis, 2006), demonstrating a subsequent rapid emergence of ToM skills that are apparent in their everyday conversations as well as in performance on ToM assessment tasks (Wellman & Lagattuta, 2000). Three year-olds understand that satisfied desires cause happiness while unfulfilled desires lead to sadness as well as a continued longing or search for the object of desire (Meltzoff et al., 1999).

False-belief understanding (also known as first-order understanding) begins to develop in the third year (Wimmer & Perner, 1983; Wellman & Laguttata, 2000; Baron-Cohen, 2000). Thus, by the age of four years, most typically developing children can correctly pass tasks in which they are required to infer another person's mental state. This finding has been frequently replicated in studies (Wellman et al., 2001) such that it represents "one of the most robust findings in the developmental literature" (Hale & Tager-Flusberg, 2003, p. 4). Baron-Cohen (2000) provided an example of false-belief knowledge in the conversation of a four-year old child. In discussing 'Little Red Riding Hood's false belief, the child stated "Little Red Riding hood thinks it's her grandmother in the bed, but it's really the wicked wolf!" (p. 7). By six to seven years of age, children can pass second-order false-belief tasks (Perner & Wimmer, 1985; Baron-Cohen, 2000) that require understanding of embedded mental states (e.g. "Mary thinks that John thinks") such as in the John & Mary task. By eight years, children understand more complex tasks that involve, for example, inferring bluff and understanding white lies such as those described in the Strange Stories task (Happé, 1994).

ToM understanding has been found to develop similarly in typically developing children from many different areas of the world, with some variation in exact age of mastery (Mayes, Klin, Tercyak, Ciccheti & Cohen, 1996; Wellman et al., 2001; Peterson et al., 2005). Chronological age has been found to have a significant effect on success (Happé, 1995; Wellman et al, 2001; Peterson et al., 2005); non-verbal cognitive ability has been found to be positively correlated as well (Abbeduto, Short-Meyerson, Benson & Dolish, 2004). Age of skill mastery in typically developing children is enhanced or slowed based on a number of factors including family experiences, family interaction style, presence or absence of siblings, exposure to co-operative play and cultural membership, as well as presentation variables in the ToM tasks (Mayes et al., 1996), although this is not an inclusive list of influencing factors (Wellman & Laguttata, 2000; Dunn & Brophy, 2005; Wellman et al., in press). For example, as discussed in Chapter 1, section 1.4, p. 12, recent findings revealed a different developmental pattern in Chinese children (Wellman et al., in press), providing evidence that cultural influences have a role in ToM development. Evidence showing environmental or cultural factors is important, because this means that manipulating the environment, or making adaptations due to cultural differences in intervention may be effective, at least theoretically.

2.3.4 Theory of Mind Skills in Children with HFA

2.3.4.1 Overview

Early studies of ToM in children with ASDs indicated that an impairment in the ability to attribute mental states to oneself and to others represented a unique deficit in individuals with this diagnosis (Baron-Cohen et al., 1985; Baron-Cohen, 1989; Leslie, 2000), with the additional supposition that the ToM deficit accounts for the severe problems in social communication and interaction that are pervasive in those with ASDs (Baron-Cohen, 1988; Tager-Flusberg, 1992). However, Yirmiya et al. (1998) presented data that directly challenged the view that ToM deficits were unique to those with ASDs. They conducted three in-depth meta-analyses based on more than 70 published studies investigating first and second-order false-belief understanding in ToM abilities. The authors compared findings of 1) individuals with ASDs and those with cognitive impairments, 2) individuals with ASDs and those with typical development, and 3) individuals with cognitive impairments to those with typical development. They reported that although individuals with ASDs/HFA performed significantly worse than either typical individuals or those with cognitive impairments, the individuals with cognitive impairments performed significantly poorer than those with typical development. Therefore, Yirmiya et al. (1998) posited that a ToM deficit could no longer be conceptualized as a core impairment that is exclusive to those with ASDs. For example, ToM deficits have been identified in other individuals, such as in those with cognitive impairment due to a specific aetiology such as Down syndrome (Baron-Cohen, 1989), cognitive impairments due to unknown or unspecified aetiologies (Baron-Cohen, 1989, Jervis & Baker, 2004), cognitive impairments due to mixed aetiologies (Happé, 1995), language impairment (Norbury, 2005), schizophrenia and in deaf individuals who were not raised in families fluent in sign language (Peterson et al., 2005). However, Yirmiya et al. (1998) pointed out that the fact that ToM has been found to be deficient in individuals with a variety of diagnoses "does not exclude the possibility that distinct elements (empathic ability, various dimensions of cognitive ability, social relations, etc.) of this ability are differentially impaired in various groups of individuals" (p. 303). As the following sections will elucidate, however, the majority of studies of the ToM skills in children with ASDs/HFA have reported significantly poorer performance as compared to typically developing children as well as the aforementioned groups with impaired ToM due to cognitive, language or emotional impairments, even when carefully controlling for language, verbal IQ and/or non-verbal cognitive ability.

2.3.4.2 False-Belief

Baron-Cohen et al. (1985) were the first to identify ToM deficits in children with ASDs through their study which assessed false-belief understanding in 20 children with HFA (mean 11;11 years). Findings were compared to those from two control groups. One group was comprised of 14 children with Down syndrome (mean 10;11 years); therefore these children were within the same approximate chronological age range as those with HFA but had a lower mean verbal age. The second control group was comprised of 27 younger, typically developing children (mean 4;05 years). The task was an 'unexpected location' paradigm (Sally-Anne task) in which the story was acted out by the examiner using individual dolls to represent 'Sally' and 'Anne.' In the task, the child is introduced to each character and told that while both dolls were watching, 'Sally' placed a marble into a basket and then left the room. While she was gone, 'Anne' moved the marble and put it into a box. Next 'Sally' returns and the child is asked to say where he/she thinks 'Sally' will look for the marble. The child is also asked two control questions about where the marble actually is and where it was in the first place. To pass, the child must therefore identify that 1) 'Sally' will look for the marble in the basket, 2) the marble is, in fact, in the box, and 3) the marble was originally in the basket. The children with HFA performed significantly worse than both control groups; only 20% of the HFA group passed, whilst 86% and 85% of the children with Down syndrome and typical development passed, respectively. The children in all groups correctly answered the control questions; therefore the poorer performance of the HFA group did not appear to be affected by the linguistic complexity of the task, or memory deficits. Thus, the authors concluded that the children with HFA showed a unique deficit in the understanding of false-belief (Baron-Cohen et al., 1985).

Steele, Joseph and Tager-Flusberg (2003) reported similar findings from their longitudinal study of 57 children with ASDs (including children with HFA), using an unexpected contents false-belief task. The non-verbal cognitive scores of the group ranged from 43 to 153 (*M* 85, *SD* 21.5). At age 7;08 years, 19% of their cohort passed the task and one year later, 32% passed. The stories were varied over time; thus different familiar containers were used to minimise effects from repeated measures. However, a control group was not included in this study, which limits the conclusions that can be made. Additionally, the investigators did not provide specific details or analyses for those children with non-verbal cognitive skills in the average range; therefore, it is possible that a higher percentage of the children with HFA passed.

Burnette et al. (2005) reported better results on false-belief understanding in 23 children with HFA (mean 11;04 years) than were reported by Baron-Cohen et al. (1985)

or Steele et al. (2003). However, the Burnette et al. (2005) group did not separate out children with Asperger syndrome, stating that "because of overlapping and confusing diagnostic criteria they were not differentiated" (p. 66). Using an unexpected contents task and comparing findings with a control group of typically developing children matched on chronological age and verbal IQ, the children with HFA performed significantly worse than the control group. In the Burnette et al. (2005) study, 57% of the HFA children passed the first order task as compared to only 20% of the children in the Baron-Cohen et al. (1985) study and 19-32% of the children in the Steele et al. (2003) study. However, ToM ability has been shown to be better in children with Asperger syndrome as compared to those with HFA (Gillberg & Ehlers, 1998); therefore, the higher percentage of children passing the task in the Burnette et al. (2005) may be a result of the inclusion of children with Asperger syndrome in their sample.

2.3.4.3 Wellman and Liu Scale

Wellman and Liu (2004) designed an assessment scale that was found to reliably assess discrete ToM abilities in typically developing children aged three to six years. By six years of age, the majority (80%) of children passed all five tasks and demonstrated that the tasks tapped a developmental progression of skills. Peterson et al. (2005) investigated this developmental progression of ToM in 36 children with HFA (mean 9;04 years) using the Wellman and Liu (2004) scale. Additionally, they used three control groups: 1) 11 native-signing deaf children (mean 10;08 years), 2) 36 non-native signing deaf children (mean 10;01 years), and 3) 36 typically developing preschool children (mean 4;06 years). The native-signing deaf children significantly outperformed all the other groups, but there were no significant differences between the HFA group, the non-native signing group and the group of typically developing children. Regarding the developmental progression across groups, findings revealed that all three control groups followed the same course as the typically developing children in Wellman and Liu's (2004) original study and Peterson et al. (2005) confirmed this with a Rasch analysis. However, the HFA group did not follow this typical progression; instead they were found to experience the most difficulty with the false-belief task (the 4th most difficult of 5 tasks). Thus, Peterson et al. (2005) suggested that false-belief understanding was uniquely difficult for children with HFA. This study represents the only published finding thus far using the Wellman and Liu (2004) scale with children with HFA.

2.3.4.4 Second-Order ToM

Baron-Cohen (1989) assessed second-order ToM understanding using the John & Mary story in ten children with ASDs (mean 15;04 years) and compared findings to chronologically younger typically developing children (mean 7;06 years) and chronological age-matched children with Down syndrome (mean 14;04 years). Baron-Cohen (1989) described the children with ASDs as a "more able subgroup" (p. 294) which seemed to indicate the group had HFA, although the verbal mental age-equivalent scores (while superior to those of the children with Down syndrome and the typically developing children) as measured by the Leiter scale were lower than their chronological age. The investigators specifically wanted the ASD group to have higher non-verbal scores in order to test their hypothesis that second-order ToM understanding reflected a specific deficit in the ASDs group, independent of their overall developmental delay. All the children in this study had previously passed a first-order false-belief task (location transfer). None of the children with ASDs passed the John & Mary task, while 90% of the typically developing children and 60% of the children with Down syndrome passed. Thus, the children with HFA performed significantly worse than both groups. Additionally, the research design included control questions that assessed whether or not the participants followed the details of the story; the ASD group performed at the same accuracy level as both control groups on all the control questions. Therefore, Baron-Cohen (1989) asserted that results provided evidence that ToM understanding was specifically impaired in the groups with ASDs.

Bauminger and Kasari (1999) also used the John & Mary task to assess second-order ToM in 22 younger children with HFA (mean 10;09 years) and 19 chronological age- and verbal IQ-matched typically developing children. Additionally they used toy props and control questions as did the Baron-Cohen (1989) study. Yet their findings were quite different; the authors reported that 68% of the children with HFA (n = 15) and 89.5% (n = 17) of the control group passed the task, with no significant difference in performance between groups. This is in contrast with the Baron-Cohen (1989) study, where none of the children with ASDs passed. However, Bauminger & Kasari (1999) considered passing the belief question as indicative of passing the entire task, yet Baron-Cohen (1989) required a full second-order justification question (the participant needed to reflect on what John thought Mary thought or vice versa). Bauminger and Kasari (1999) did provide details about this, noting that 13 children with HFA (59%) passed both the belief question and the justification question (this scoring did not affect the control group). Individual data were not provided so means across groups can not be compared using this adjusted scoring criteria. Even with the scoring adjustment, however, Bauminger and Kasari's (1999) findings were decidedly more encouraging than those reported by Baron-Cohen (1989). Bauminger and Kasari (1999) suggested that the difference in findings was probably due to the fact that their group had HFA and they maintained that Baron-Cohen's (1989) group did not. This does not completely explain the differences in findings however, as the Bauminger and Kasari (1999) HFA group had the same non-verbal mental age as the Baron-Cohen (1989) ASD group and were almost five years younger chronologically. It is more likely that the better performance by the Bauminger and Kasari (1999) group was due to their group's higher verbal IQ ability as opposed to the non-verbal skill level.

A study by Dahlgren and Trillingsgaard (1996) provides some support for the finding by Bauminger and Kasari (1999) that individuals with HFA are not as impoverished in their second-order understanding as Baron-Cohen's (1989) findings indicated. They assessed second-order ToM with the John & Mary story in 20 children with HFA (mean 10;07 years) who, like the children in the Bauminger and Kasari (1999) study, had both verbal and non-verbal IQ skills within the normal range. The study compared findings with two control groups of children; one group with Asperger syndrome and one group with typical development. All groups were matched on verbal mental age scores. The HFA group achieved a passing rate of 60%, which is almost identical to the adjusted passing rate found in the Bauminger and Kasari (1999) study. However, the HFA group in the Dahlgren and Trillinsgaard (1996) study performed significantly worse than the typically developing group.

Burnette et al. (2005) also reported results for second-order understanding in 23 children with HFA (mean 11;03 years) using the John & Mary story. As discussed earlier, the authors did not differentiate between children with Asperger syndrome and HFA. Additionally, there was no justification response required; instead each child only had to tell where he/she thought Mary thought John would go to buy his ice-cream and where John had actually gone to buy his ice-cream. Thirty percent of the HFA group passed the task, as compared to 75% of the control group matched on chronological age and verbal IQ, with the difference between groups reaching significance. These results are surprising given that the group may have included children with Asperger syndrome (who would be expected to perform better on ToM tasks). Additionally, the children were not required to provide a verbal justification to pass the task. As it is the justification that really assesses the second-order ToM knowledge of an individual, leaving this question out should actually have made the task easier and more children, rather than less, would be expected to pass. Burnette et al. (2005) suggested that the lower mean performance IQ in the HFA group compared to that of the control group may have possibly accounted for the poorer performance.

Norbury (2005) also assessed second-order ToM skills with the John & Mary story in a group of 31 children with HFA (mean 12;05 years) and compared findings to groups of children with non-verbal cognitive ability within the normal range matched on chronological age. The groups were comprised of: 1) children with language impairments (n = 28), 2) children with ASDs, but no language impairment (n = 29) and 3) typically developing children (n = 34). The HFA group and the language impairment group obtained similar results and both groups performed significantly worse than either the ASD group or the typically developing children. Forty-three percent of children in the language impairment group passed the task, whilst 36% of the HFA group passed. Norbury's (2005) investigation did require children to provide a justification response although it was less stringent than that required by Baron-Cohen (1989). Thus the percentage of those with HFA who passed the task is similar to the finding by Burnette et al. (2005).

2.3.4.5 Higher-Order Tasks (Strange Stories)

Happé (1994) assessed higher-order ToM understanding in 18 individuals with ASDS (majority had HFA) ranging in age from 8;11 to 45 years (mean 20;08 years) and compared results with three groups: 1) 26 typically developing children (mean 8;08 years), 2) 11 individuals with cognitive impairment (mean 19;05 years) and 3) 10 typical adults (mean 20;06 years). The Strange Stories task was used and was comprised of 24 short stories, each accompanied by a picture and two test questions. The individuals with ASDs and those with cognitive impairments were tested by an examiner in a quiet room in either their school or home; the typical adults were given the stories to take home and instructed to read and answer them without input from anyone else. The typical children were given the stories by their classroom teacher as part of the daily classroom activities, but they were done individually, with the teacher ensuring children did not help each other. The individuals with ASDs performed significantly worse than all the other groups. Happé (1994) noted the individuals with ASDs gave inappropriate or incorrect mental state reasoning for the stories, even though they had greater age than the young typical controls and had a higher verbal IQ than the cognitively impaired group.

Joliffe and Baron-Cohen (1999) reported findings which replicated those by Happé (1994). They tested three groups, each with 17 individuals (mean 30 years) matched on chronological age, performance IQ, verbal IQ and full scale IQ. One group had HFA, another group had Asperger syndrome and the third group was comprised of typical adults. Both the HFA and Asperger groups performed significantly worse than the typical group on their responses to mental state justification questions; additionally both groups were significantly worse at providing explanations that were appropriate to the context of the stories. The HFA group had the lowest scores, but they did not differ significantly from the group with Asperger syndrome.

2.3.4.6 Relationship between Chronological Age and ToM

There is mixed information on the relationship between chronological age and ToM in children with ASDs/HFA. Steele et al. (2003) reported significant correlations ($p < .01$) between both chronological age and non-verbal cognitive scores with ToM ability in a longitudinal study of 57 children with ASDs (including HFA) at a mean age of 7;08 years. These correlations remained at the reassessment one year later. Likewise, Peterson et al. (2005) reported significant correlations between chronological age and ToM ability in 36 children (mean 9;04 years) with HFA. Other investigators have found the opposite. Happé (1995) reviewed an extensive corpus of studies which have investigated false-belief understanding in individuals with ASDs and combined data from five years of research to create a pool of 70 children with ASDs (mean 12;10 years). However, the meta-analyses revealed no significant correlations existed between chronological age and ToM. Muris et al. (1999) found higher verbal and performance IQs significantly and positively correlated with better ToM skills but not with chronological age in a group of 20 children (mean 9;04 years) with pervasive developmental disorders (8 had HFA). The differences in these findings may be due to the varying ages of the participants, the specific subgroup(s) of ASDs included in each study and the differing sample sizes.

2.3.4.7 Relationship between Verbal Ability and ToM

Happé (1995) showed that verbal ability (as measured by receptive vocabulary scores on the British Picture Vocabulary Scale) was a reliable predictor of ToM ability and was highly correlated with ToM performance in children with ASDs and those with typical development. However, the children with ASDs required higher verbal skills to pass the tasks than either a group of typically developing children or a group of children with cognitive impairment. The children with ASDs required a minimum verbal mental age of 5;06 years to pass false-belief tasks, but after a verbal age of 11;07 years was reached, none of the children failed. Happé (1995) suggested this finding could be interpreted two ways: either a verbal mental age of 11;07 is adequate to pass false-belief tasks, or a verbal mental age of 11;07 cannot be reached without false-belief understanding. Steele et al. (2003) also reported vocabulary ability correlated highly with ToM ability in their longitudinal study of ToM skills in 57 children with ASDs (including children with HFA) at both a mean age of 7;08 years and at the follow-up assessment one year later.

Siegal, Carrington and Radel (1996) proposed that the use of explicit questioning in a ToM task paradigm would provide a more transparent clue that a mental state response was required than the use of implicit questions. For example, the explicit wording in the questions 'Where will John look for his kitten first' or 'Where does John think his kitten is' was hypothesised to be more easily understood than a question such as 'Where will John look for his kitten'. Bibby and McDonald (2005) investigated this difference in wording in a study of 15 adults with traumatic brain injury and a control group of 15 age-matched typical adults. Findings indicated that both groups performed significantly better on the explicitly worded tasks, thus providing further evidence of the importance and influence of language on ToM task performance.

An important finding regarding the directional relationship between language and ToM in children with typical development was reported by Astington and Jenkins (1999). They tested 59 typically developing children on three separate occasions over seven months (mean 3;04 years at time of 1st testing) using an unexpected location false-belief task, unexpected contents false-belief task and an appearance-reality task (a rock which is painted to look like a sponge is shown to a child. The child needs to tell what object it looks like, what it really is, what another person would think it is and what the child thought it was when he/she first saw it). Each child was given all ToM tasks on three occasions; additionally the Test of Language Development (Hresko, Reid & Hammill, 1981) was administered at each time and scores were computed separately for the syntactic and semantic items. The authors investigated whether later language development was predicted by earlier ToM ability or if later ToM ability could be predicted by earlier language skills. Findings indicated that language reliably and significantly predicted ToM scores from the first testing session to the second, as well as from the first testing session to the third. However, ToM ability did not predict any changes in language over time. Astington and Jenkins (1999) ran the analyses a second time (to preclude the possibility that their findings were simply an artefact of psychometric issues), adjusting the language scores to reduce the variance and make them more comparable to the variance observed in the ToM scores; even so, their results were the same. Moreover, these findings were supported by a large meta-analysis of false-belief studies (Milligan et al., in press).

2.3.4.8 Relationship between Grammatical Ability and ToM

Astington and Jenkins (1999) reported that, in addition to the finding that language predicted ToM performance, syntax made an independent contribution to the prediction of change over time in the ToM scores. A similar finding was reported by Fisher, Happé and Dunn (2005). They examined the relationship between grammatical ability and false-belief performance in 58 children (mean 10;09 years) with ASDs (not HFA) and compared their results to those from 118 children with moderate learning difficulties due to mixed aetiologies (mean 12;02 years). The children with moderate learning difficulties outperformed those with ASDs; however there was a significant relationship between ToM and grammatical ability apparent only in the group of children with ASDs. Results indicated that performance on language (receptive vocabulary and grammar) predicted false-belief performance in 90% of the ASD group and in 65% of those with learning difficulties. Grammatical ability was the best predictor of false belief performance, over and above receptive vocabulary in the ASD group, but added no improvement in the prediction in the children with learning difficulties. Thus, the authors concluded that grammatical ability has a distinctive role in the development of false-belief understanding in children with ASDs (Fisher et al., 2005).

de Villiers and de Villiers (2003) have reported evidence which indicated that understanding of sentential complements is a prerequisite for ToM understanding. There are two classes of verbs that take sentential complements, verbs that indicate communication (e.g. "He *said* that he was going to see a movie") and verbs that indicate a mental state ("She *thinks* he went to see a movie"). The sentential complement connects a clause that is true with an embedded clause that may or may not be false. de Villiers and Pyers (1997) studied two groups of typical preschoolers (n = 28), assessing them on false-belief and sentential complement understanding (on its own, not within the false-belief tasks) over the course of one year. Results indicated that the ability to process sentential complements was a significant predictor of later false-belief understanding but not vice versa. A similar finding was reported following a study by de Villiers, de Villiers, Schick and Hoffmeister (2000). 86 deaf children from oral-only schools and 90 fluently signing deaf children, ranging in age from four to seven years, were assessed on false-belief and sentential complement understanding as well as on additional measures of language. The researchers found that vocabulary size and understanding of embedded sentential complements were the most reliable predictors of ToM skills but that basic syntactic skills (not including sentential complements) were not.

2.3.4.9 Relationship between Pragmatic Ability and ToM

Jervis and Baker (2004) studied the relationship between pragmatic ability and ToM in children and adults with cognitive impairments without specific aetiologies. They matched 20 children (mean 11;03 years) and 20 adults on both non-verbal (mean 6;05 years) and verbal (6;09 years) mental age and assessed ToM with a first-order false-belief task, using the Sally-Anne task. Pragmatic skills were assessed using the socialisation scale from the Vineland Adaptive Behaviour Scales (Sparrow et al., 1984) which assesses personal and social independence using a semi-structured interview with family members or caregivers. Significant positive correlations were found between ToM scores and the Interactive Sociability, Intentionality, Interpersonal Relationships and Play and Leisure subscales in the group of children; although the authors cautioned that the results provided no information of the direction of causality between ToM and pragmatics. Additionally, the children significantly outperformed the adults on the ToM tasks, but no correlations between social ability and ToM were found with the adult data. This is an interesting finding, as the discrepancy cannot be explained by verbal or non-verbal abilities. The authors suggested that the results may have been due to the fact that the Sally-Anne task uses dolls which the adults may have found demeaning, although they added anecdotally that the adults had not appeared to be less motivated than the children during the assessment. Jervis and Baker (2004) further suggested that ToM ability may decline over time due to the long-term experience of being cared for and directed by others. The fact that the more socially competent children performed better on ToM tasks highlights the need for effective social intervention for children with HFA who are significantly impaired in the area of pragmatics.

Norbury (2005) investigated the relationship between ToM ability and use of metaphors, contending that metaphors "require the listener to infer the speaker's intention that the statement would be interpreted in a non-literal fashion" (p. 384) and therefore require pragmatic ability. Results from a group of 31 children with HFA (mean 12;05 years) were compared to results from three groups of children matched on chronological age: 1) 28 children with language impairment (all with non-verbal cognitive ability within the normal range), 2) 29 children with ASDs but with no language impairment, and 3) 34 children with typical development. All were assessed on measures of first- and second-order ToM as well as on broad semantic knowledge and use of metaphors, similes and synonyms in a sentence-completion task. There were 18 sentences presented: six each for metaphor, simile and synonyms. Each sentence was read aloud by the examiner and the child was instructed to choose which written word out of four possible choices best completed the sentence. Each group had the most difficulty with the metaphor sentences than the other types. The HFA group performed significantly worse on all three sentences types than the ASD and typically developing groups. The HFA group also performed worse than the language impaired group on all sentence types, but these differences did not reach significance. To examine the relationship between ToM and comprehension of metaphors, Norbury (2005) created groups based on ToM performance (those who failed both tasks; those who passed a first-order task, but not a second-order task; those who passed both first- and second-order tasks; and the control group (performed at ceiling on ToM and metaphor tasks) using hierarchical regression analyses with accuracy on metaphor items as the outcome variable. Results indicated that chronological age, receptive vocabulary and semantic knowledge accounted for 37% of the variance, whilst ToM did not account significantly towards the variance. Therefore, Norbury (2005) asserted that rather than providing evidence that ToM understanding is necessary for understanding metaphors (and more broadly, a facet of pragmatics), the findings provided additional support regarding the strong relationship between language and ToM.

2.4 EMPIRICAL STUDIES OF LANGUAGE, PROSODY AND ToM

The only data available about the relationship between all three areas are from a single study that has not yet been published. McCann and Carroll et al. (2006) reported preliminary findings from a study of language, prosody and theory of mind in children with Asperger syndrome (mean 13;09 years). They assessed language and non-verbal cognition and compared these skills with receptive and expressive prosodic abilities as assessed with Profiling Elements of Prosodic Systems-Children (Peppé et al., 2003) as well as ToM abilities using the Strange Stories (Happé, 1994). Prosody scores correlated highly with vocabulary, receptive grammatical ability, expressive language, non-verbal cognition and ToM scores.

2.5 AIMS AND HYPOTHESES

The literature review highlighted problems in generalising findings due to use of small clinical sample sizes as well as inconsistent or vaguely described adherence to current diagnostic criteria for HFA. Therefore, the current study intends to use a relatively large and tightly defined cohort of children with HFA to produce findings which can be generalised to other children with HFA, as well as replicated in future investigations.

2.5.1 Aims

The main aims of this investigation are:

- To describe the relationship of language, prosody and ToM skills to answer:
  - What are the individual language profiles of children with HFA and how do they compare to the HFA group as a whole?
  - Will grammatical and expressive language skills be more impaired than vocabulary and articulation skills, as reported in the literature?
  - How will prosodic abilities in children with HFA compare to a group of typically developing children matched on verbal mental age?
  - Will the children with HFA show greatest impairments on contrastive

  - stress and affect tasks, as reported in the literature?
  - Are there differences in prosodic ability within structured tasks between children with HFA who have atypical expressive prosody in conversational speech as compared to those who do not?
  - What are the ToM skills in this group of children with HFA?
  - Using a developmental ToM assessment, will children with HFA follow the same developmental pattern as children with typical development, or will they show a different order of development, as has been reported?
  - Will story length for ToM tasks affect performance, as has been suggested?
  - Will ToM results correlate with language measures and if so, which ones?
  - Does ToM correlate with prosody after controlling for language ability?
- To assess language development over a two-year period in children with HFA to answer:
  - What are the group developmental trends in vocabulary, grammar, articulation, expressive language and pragmatic skills; will language skills support previous findings that children with HFA continue to follow a delayed but typical trajectory or will they support findings that indicate children's language development will plateau?
  - Will the cohort of children with HFA continue to show heterogeneity of skills, as would be expected from the literature?
  - What are the group changes in prosody skills over time?
  - Will prosodic abilities continue to correlate with language measures, as has been reported?
- To inform future research and practice about children with HFA to:
  - Make recommendations for assessment and intervention methods in children with HFA
  - Discuss whether language, prosody and ToM deficits may reflect a single, core impairment in children with HFA

2.5.2 Hypotheses

Based on the evidence reported in the literature, it is predicted that:

- Children's language and communication skills, as measured by standardised scores, will continue to be well below those of their typical peers;
- Prosodic skills over time will continue to be impoverished as compared to language-age matched peers;
- Children with HFA who show poorest performance on the prosody assessment will also have lowest scores for the ToM tasks.

2.6 SUMMARY

This chapter has provided details from the research literature about the language, prosody and theory of mind skills in children with HFA, with reference to the same abilities in children with typical development. The main aims and hypotheses for the current study were delineated. In the next chapter, the methods used for this study are presented.

3

Methodology

This chapter is divided into two sections; the first reflects on the theoretical issues and rationales involved in the design of the methodology and the second section will detail the data gathering process. Within the first section, information will be presented on assessment of language, prosody, then ToM to continue with the order presented in earlier chapters.

This thesis reports longitudinal data gathered at two points in time, approximately 2.5 years apart; however, only the data described as Time point 2 was gathered specifically for the current study. The data from Time point 1 is from a study entitled "Prosodic Ability in Children with Autism" which was completed in 2004 at Queen Margaret University College, funded by the Chief Scientist Office of the Scottish Executive. Details about this project can be found in Peppé and McCann (2003); McCann and Peppé (2003); Gibbon et al. (2004); Peppé et al. (in press) and McCann et al. (in press). Ethical approval was granted and a cohort of 31 children with high-functioning autism was gathered for the project; subsequently their details were shared with this author for the current study reported here. The data protocol was similar but not identical at the two Time points; the details and rationale for the protocol adopted at Time point 2 will be elucidated in the section that follows.

3.1 ASSESSMENT OF CHILDREN WITH HFA

3.1.1. Standardised Assessments

Most research studies which aim to investigate language skills in children with ASDs use standardised assessments with normative data to compare outcomes with typically developing children, or language sampling measures, or a combination of standardised measures and language samples. These measures are designed to ascertain typical, deviant, or delayed language skills in children and are therefore informed by the wealth of information on typical language development.

Regarding the use of standardised assessments, there is some conflicting evidence regarding their usefulness for children with ASDs. Tager-Flusberg (2000b) noted that the highly structured nature of many standardised assessments is actually well-suited to the performance style of children with ASDs. For example, standardised assessments are usually presented with tangible objects or pictures in a one to one situation in a room with reduced auditory and visual distractions, which would make the child with an ASD more at ease. On the other hand, children with ASDs have a propensity to perseverate in their responses which may lead to choosing an incorrect response when, in reality, a child does know the item in question. For example, in a receptive task with four picture choices, the child may tend to choose the same location as a result of perseveration. Expressively, a child may continue to provide verbal information from a previous response. In addition, many standardised assessments follow a continuum from easier to more difficult items and require the child to fail on a number of items to reach ceiling. This can be difficult even for a typically developing child who does not like to be wrong, but can be especially stressful for children with ASDs. These factors could possibly affect the reliability of a child's score, either by over- or under-estimating their true language and non-verbal cognitive abilities.

3.1.2 Language Sampling

In the field of speech and language therapy, gathering a language sample in the most naturalistic setting or settings is considered to be the best way to obtain authentic information about a child's production of language and social interaction skills. However, gathering a language sample from children with ASDs presents several challenges. For example, it is generally done with as few structural parameters as possible in order to gather the most naturalistic sample. Children with ASDs have difficulty with unstructured situations and open-ended tasks. Moreover, the difficulty in engaging or sustaining dynamic conversation with others is one of the most significant challenges for children with ASDs. Without specific demands to speak, children with

ASDs will be less likely to do so, as they are generally solitary by nature. However, the heterogeneity of children with ASDs must be considered, as there are children with ASDs, particularly those with HFA or Asperger syndrome, who might be verbose.

Based on the positive aspects of assessing language via standardised tools and the difficulties inherent in gathering language samples from children with ASDs, as well as the need to keep the number of testing sessions to a minimum, it was decided that a corpus of standardised language measures would be used to assess the language of the cohort with HFA. In addition, the Time point 1 data from the CSO study was gathered via administration of standardised measures; therefore it was logical to use a similar protocol at Time point 2. This would allow measurement of stability and change in individual children for a range of skills known to be potentially impaired in children with HFA, such as prosody, expressive language and pragmatics; as well as skills that are thought to be strengths for the same children, such as non-verbal cognitive skills.[1] Furthermore use of a similar assessment protocol would allow examination of the direction of change, i.e., progression or regression of skills.

3.1.3 Choice of Assessment Measures

Table 3-1 lists the complete testing protocols used at each of the two time points and highlights the differences between them. At Time point 1, the tests assessed, in sum, receptive vocabulary, expressive language, pragmatics, articulation, non-verbal cognitive skills and reception of grammatical structures. The tests used were tools that are frequently used in the field of speech and language therapy and research to gather a comprehensive assessment of a child's skills and deficits. In the application to the Chief Scientist Office, Gibbon, Peppé, O'Hare and Rutherford (2001, p. 10) stated the following rationales for the test battery used at Time point 1:

> "First, the tests provide age norms up to, or above, 13 years (the upper age of participants). Second, they measure a broad range of relevant skills, including ability to handle grammar/vocabulary receptively and expressively, articulation and general nonverbal abilities. Third, the tests are robust procedures used

1 Although non-verbal cognitive skill is a construct that is separate from language, it will be discussed here under the heading of language.

> frequently in research studies. For example, Conti-Ramsden et al. (1997) used a similar battery in a series of studies of 7-year-olds with language impairment. Fourth, most children, including those with language impairment, can complete the battery in one session."

At Time point 1, testing was conducted over two 60-minute sessions. For the study at Time point 2, ethical approval was sought for two 90-minute sessions to accommodate additional tests. Therefore, given that the children with HFA were approximately two years older, the likelihood that they could complete the original test battery along with the additional tests was considered a realistic goal for Time point 2 data. Moreover, the original test battery continued to provide norms for the upper age of participants at Time point 2 (16 years). Finally, direct comparison between the same tests at different points in time could provide a useful look at development of language and non-verbal cognitive ability both within the individuals with HFA and within the group as a whole.

3.1.3.1 Examiner Details

At both Time points, all assessment measures were administered by certified speech and language therapists with extensive experience working with children with ASDs. At Time point 1, the researcher/speech language therapist was a speaker of Scottish English. At Time point 2 assessment measures were administered by the author of the current study, who is a speaker of American English; therefore, modifications were made to counteract any impact of the accent, as will be discussed in Section 3.1.8 (pp. 94-95). At Time point 2, the term 'this examiner' will refer to the author of the current study.

Table 3-1. Assessments Administered at Time Points 1 and 2; shaded areas indicate differences at Time point 2

Tests administered at Time 1 (C.S.O. funded study, Gibbon et al., 2004)	**Tests administered at Time 2 (for current study)**
Children's Communication Checklist (CCC) – Completed by Teacher or Speech Language Therapist	Children's Communication Checklist 2nd Edition (CCC-2) – Completed by child's parent or guardian
Clinical Evaluation of Language Fundamentals-3 U.K. Version (CELF-3) Expressive Subtests	Clinical Evaluation of Language Fundamentals-3 U.K. Version (CELF-3) Expressive Subtests
Test for Reception of Grammar (TROG)	Test for Reception of Grammar 2nd Edition (TROG-2)
British Picture Vocabulary Scale 2nd Edition (BPVS-II)	British Picture Vocabulary Scale 2nd Edition (BPVS)
Goldman-Fristoe Test of Articulation II (GF)	Goldman-Fristoe Test of Articulation II (GF)
Raven's Progressive Matrices (RPM)	Raven's Progressive Matrices (RPM)
Profiling Elements of Prosodic Systems in Children (PEPS-C)	Profiling Elements of Prosodic Systems in Children (PEPS-C)
	Expressive One-Word Picture Vocabulary Test, Revised (EOWPVT-R)
	Theory of Mind Assessment Battery

3.1.4 Assessment Measures of Language and Cognitive Skills

The assessments used at Time point 1 are described in detail in the sections that follow. All departures from this battery that took place at Time point 2 are detailed and explained in Section 3.1.6 onwards.

3.1.4.1 Expressive Language

The expressive subtests of the Clinical Evaluation of Language Fundamentals-3 UK Version (CELF-3) (Semel, Wiig & Secord, 2000) are frequently used to assess expressive language development. There are three subtests which are presented. For children aged 6 – 8 years, the Word Structure subtest is used. It requires the child to complete sentences that are eliciting grammatical and morphological structures such as regular and irregular plurals and verb tenses, as well as use of possessives and pronouns. Most, but not all, of the prompts given by the examiner are accompanied by coloured pictures. For example, a picture of one horse on the left of the page and two horses on the right of the page is presented with the prompt 'here is one horse and here are two …'

The Formulated Sentences subtest requires the child to construct a sentence about a coloured picture using a targeted word. For example, a picture of a mother serving food to two young children at a table is presented and the examiner tells the child to 'make a sentence about this picture using the word gave.' The Recalling Sentences subtest requires the child to repeat verbally presented sentences of increasing length and complexity, without any visual cues or verbal repetitions. Children aged 9 years and over are then given the Sentence Assembly subtest which presents written words, accompanied by a verbal presentation of the words, that they must arrange to make two different sentences. Composite age-equivalent, standardised scores and percentile ranking for expressive language are calculated on the three subtests given.

3.1.4.2 Receptive Grammar

Receptive grammatical skills were measured using the Test for Reception of Grammar (TROG) (Bishop, 1989). The child must choose a picture from a choice of four that best matches the content of the sentence spoken by the examiner. Repetitions of the stimuli are allowed, but noted on the form for additional information. This assessment yields age-equivalent and standardised scores as well as percentile ranking.

3.1.4.3 Vocabulary

Receptive vocabulary skills were measured using the British Picture Vocabulary Scale-II (BPVS) (Dunn, Dunn, Whetton & Burley, 1997). The child is asked to point to the picture from a choice of four which best matches the single word spoken by the examiner. The words gradually become more difficult and ceiling is reached when a child makes an error on eight or more responses in a set of ten. The BPVS yields standardised and age-equivalent scores and percentile ranking. The age-equivalent score of the BPVS was used as a measure of verbal mental age for matching to the control group, as has been done in many previous studies (for a review, see Mottron, 2004).

3.1.4.4 Articulation and Phonology

Articulation of English consonants was assessed using the Goldman Fristoe Test of Articulation, 2nd Edition (GF) (Goldman & Fristoe, 2000), a frequently used measure of consonant production in initial, medial and final positions within single words. Results yield age-equivalent scores, standardised scores and percentile ranking. In addition, analysis of errors can be used to profile phonological process skills and deficits. Although the GF is a useful measure, it was standardised on normative data from American children and some of the words the test attempts to elicit are somewhat unfamiliar to Scottish children (e.g., wagon, slide).

3.1.4.5 Pragmatics

The children's pragmatic skills were assessed using the Children's Communication Checklist (CCC) (Bishop, 1998), a questionnaire that was completed by each child's classroom teacher or speech and language therapist. The CCC was designed as a diagnostic tool to distinguish between children with specific language impairment and those with ASDs. Whilst it was neither specifically designed as an assessment of pragmatic skills for children with ASDs nor does it have normative data, it yields a score indicating level of pragmatic impairment based on presence of abnormal social interaction behaviours.

3.1.4.6 Non-Verbal Cognitive Ability

Raven's Progressive Matrices (RPM) (Raven et al., 1986) were used to assess non-verbal cognitive skills. With minimal verbal instruction, the child is told to find a missing piece in a visual design. For each design, there are six pictured choices and the child points to the one that completes the design. The score yields an age-equivalent and a percentile rank which are based on normative data. These data were converted to standardised scores using the percentile ranks table.

3.1.5 Assessment of Prosodic Ability

Receptive and expressive prosodic ability was assessed using the Scottish version of Profiling Elements of Prosodic Systems in Children (PEPS-C), an assessment that was developed by Peppé et al. (2003) and described in detail by Peppé and McCann (2003). PEPS-C is administered via computer and is comprised of six subtests that assess the ability to understand and use four distinct prosodic functions (Turn-End, Affect, Chunking and Focus tasks) and to discriminate between and produce prosodic forms (Intonation and Prosody tasks). PEPS-C is based on a psycholinguistic framework (Stackhouse & Wells, 1997) incorporating two dimensions: 1) input or comprehension and output or expression and 2) function or top-down processing and form or bottom-up processing. A receptive (input) subtest always precedes the expressive (output) one targeting the same ability. All of the auditory stimuli were pre-recorded by speakers of Scottish English dialect and the sound files embedded in PEPS-C program. Each of the subtests will be described in turn and the full instructions for each subtest as presented to the participants are listed in Appendix III (pp. 248-250).

Before the subtests are presented, the child completes a vocabulary check to ensure he or she knows the names of all the items in the test, as well as the symbols used for 'same' and 'different.' The items are named for the child if he or she does not know them; previous knowledge of all the vocabulary items is not a prerequisite for taking the assessment. As will be described, each of the input tasks provides two possible response choices on the computer screen and a line clearly demarcates between them. Depending on the age and ability of the child, responses are indicated by clicking on the chosen picture with a computer mouse or by pointing to the chosen picture on the computer screen. Each input and output task begins with one demonstration item and two practice items for the child, followed by 16 test items. Repetition of stimuli is allowed for any of the items.

3.1.5.1 Turn-End Tasks

The Turn-End Input subtest requires the child to identify if the name of a food has been spoken as a statement or as a question. Two pictures appear side by side on the computer screen (see Figure 3-1); one shows a person with a book and the food (this indicates the person is naming the food as a statement), the other shows a person with the food and a question mark (indicating the food is named as a question). The child must choose one of two pictures to indicate whether he or she interpreted it as having been produced as a question or as a statement.

For the Turn-End Output task, the child must say the name of the food in the manner that matches a single picture on the computer, either the food with the question mark (requires rising intonation to sound questioning) or the food with a book (requires falling intonation to sound like a statement). To be sure the examiner's judgment is solely based on the child's verbal response, the examiner does not look at the computer screen. In addition, items appear in random order so the examiner does not know if the child is seeing the book or the question mark. Using a specially marked keypad, the examiner indicates if the spoken word is judged to have been produced as a statement or a question.

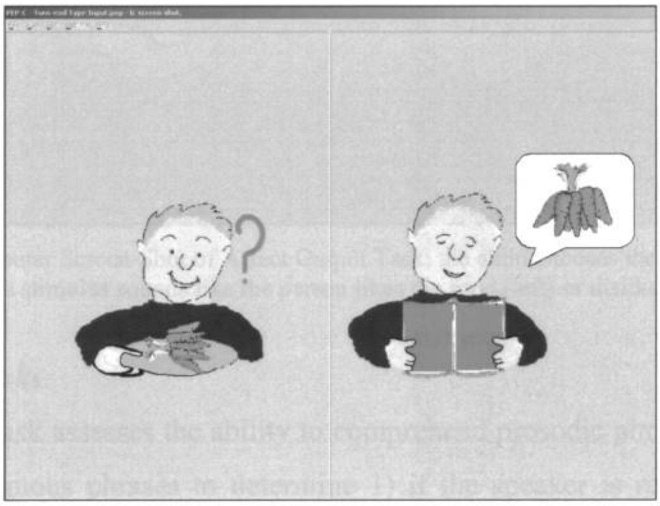


Figure 3-1. Computer Screen-Shot of Turn-End Input Task; the child chooses the picture that corresponds to a question (left) or statement (right)

3.1.5.2 Affect Tasks

The Affect Input task assesses the ability to determine if the narrator's affective prosody indicates liking or disliking a food. Again, two pictures appear side by side on the computer screen; one side shows the named food with a happy face, the other side shows the named food alongside a sad face. The child chooses the picture that matches how the voice sounds.

For the Affect Output task, a single picture of a food is presented on the screen and the child is told to say the name of the food so the listener can tell if he or she likes or dislikes the item. The examiner looks away from the child so as not to be influenced by cues other than the child's affective prosody and indicates his/her judgment on the keypad; then a split screen appears with a happy face on one side and a sad face on the other (see Figure 3-2). The child then clicks the mouse or points to the face that matches how he or she feels about the food.

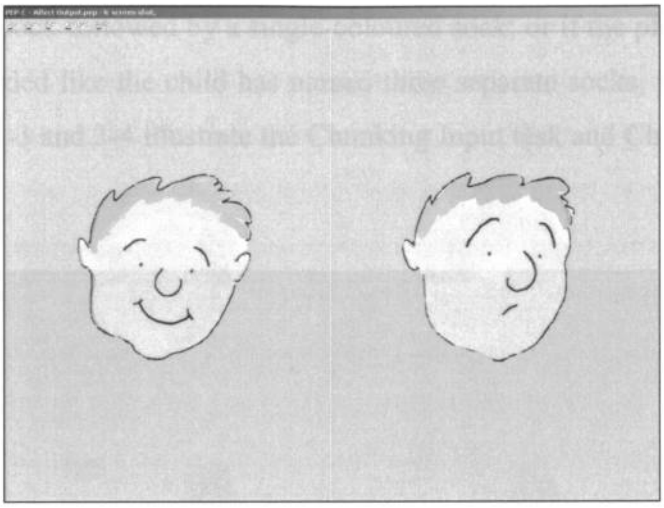


Figure 3-2. Computer Screen-Shot of Affect Output Task; the child chooses the picture that matches whether a stimulus sounds like the person likes the food (left) or dislikes the food (right)

3.1.5.3 Chunking Tasks

The Chunking Input task assesses the ability to comprehend prosodic phrase boundaries in syntactically ambiguous phrases to determine 1) if the speaker is referring to two items, one of which is a compound noun (e.g., fish-fingers and fruit) or three items (e.g., fish, fingers and fruit) or 2) if the speaker is referring to a two-coloured sock then a single-coloured sock (e.g., pink-and-black and green socks) or a single-coloured sock then a two-coloured sock (e.g., pink and black-and-green socks) The computer screen shows 1) the two-item combination on one side and the three-item combination on the other; or 2) the single-coloured sock followed by the two-coloured sock or vice versa and the child indicates which picture set best matches the phrase he or she has heard.

In the Chunking Output task, the child sees either 1) a group of two or three items, 2) a group of single-coloured followed by two-coloured socks or 3) vice versa and is told to name what he or she sees. The examiner judges if the child has produced the prosodic boundary after the first item (e.g., fish, fingers and fruit); after the compound noun combination and before the second item (fish-fingers, and fruit); or ambiguously (uneven or unclear boundaries). When the child names pictures of the sock combinations, the examiner judges if the child has produced the phrase boundary to sound like the child is describing a single-coloured sock followed by a two-coloured sock; a two-coloured sock followed by a single-coloured sock; or if the phrase boundary was ambiguous (sounded like the child has named three separate socks, which is never illustrated). Figures 3-3 and 3-4 illustrate the Chunking Input task and Chunking Output task, respectively.

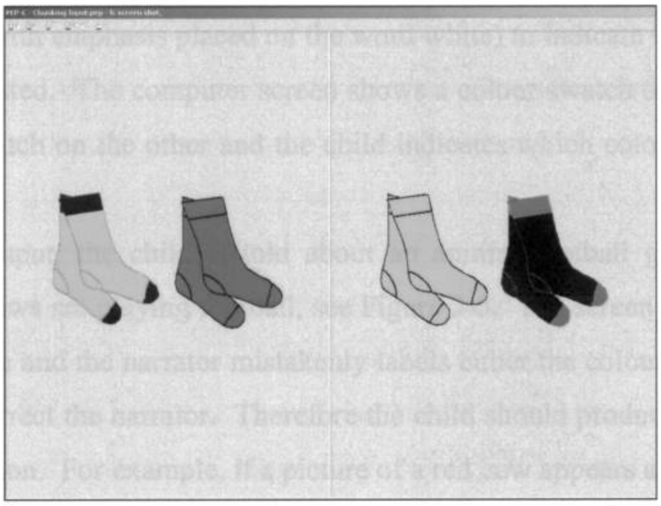


Figure 3-3. Computer Screen-Shot of Chunking Input Task; the child chooses the picture that matches whether the stimulus sounds like it is describing a pink-and-black and green sock (left) or a pink and black-and-green sock (right)

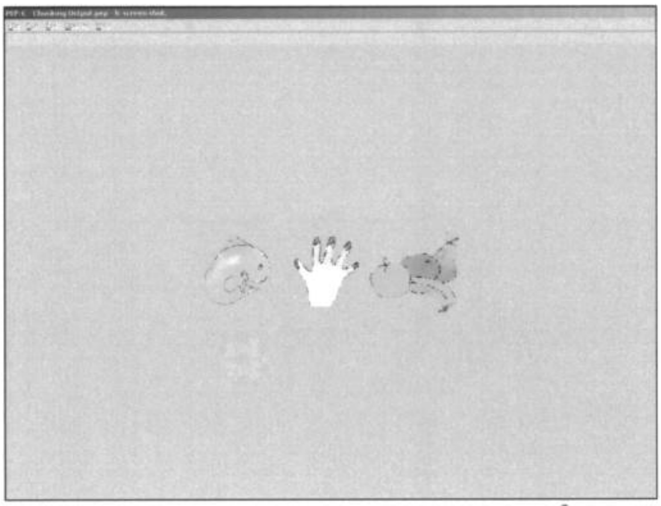


Figure 3-4. Computer Screen-Shot of Chunking Output Task; the child is instructed to name the picture, e.g., fish, fingers and fruit

3.1.5.4 Focus Tasks

The Focus tasks assess comprehension and production of contrastive stress, that is, use of stress on a word to indicate new or clarified information. In Focus Input, the child is told that the person on the computer came home with new socks but realised she forgot to buy the colour she really wanted. For example, the narrator might say, 'I wanted blue and WHITE socks' (with emphasis placed on the word white) to indicate that those were the socks she had wanted. The computer screen shows a colour swatch on one side and a different colour swatch on the other and the child indicates which colour the narrator wanted.

For Focus Output, the child is told about an animal football game in which coloured sheep and cows are playing football, see Figure 3-5. The screen shows either a coloured cow or sheep and the narrator mistakenly labels either the colour or the animal and the child must correct the narrator. Therefore the child should produce stress on the new, correct information. For example, if a picture of a red cow appears and the narrator says, 'The blue cow has the ball' the child should respond, 'The RED cow has the ball'. Alternatively if the narrator says, 'The red sheep has the ball,' the child should put the contrastive stress on the animal, e.g., 'The red COW has the ball.' The examiner indicates on the keypad if the child has stressed the animal, the colour, or if he has produced them ambiguously (with equal or indeterminate stress on both words).

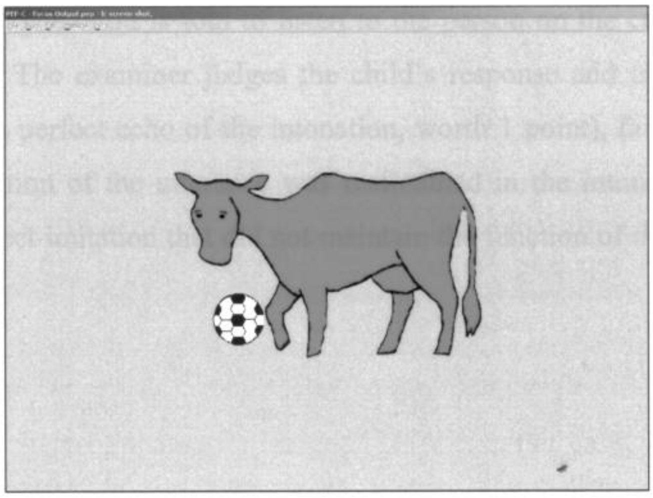


Figure 3-5. Computer Screen-Shot of Focus Output task; the child must correct errors made by the narrator. If the narrator says 'the blue cow has the ball' the child should say 'the RED cow has it'

3.1.5.5 Form Tasks

The two form tasks (Intonation and Prosody) use the same presentation method and visual stimuli (see Figure 3-6). Both Intonation and Prosody Input tasks assess auditory discrimination skills based on stimuli recorded with a laryngograph, an instrument used to record the laryngeal movements produced in speech. When played back, a laryngograph waveform is similar to low-pass filtered speech and retains only information about overall rhythm, including pauses and boundaries, pitch and intensity. To the listener, the laryngograph recordings sound like humming and they are similar to hearing speech in an adjacent room when there are not enough auditory signals to perceive the phonemes or lexical content, thus the message is unintelligible. The laryngograph recordings were produced by speakers reading the same stimuli that are presented in the four function tasks. The Intonation Input items are the single words used in the Turn-End and Affect tasks; the Prosody Input items are the phrase length stimuli used in the Chunking and Focus tasks. The child is told to listen to two different noises and then indicate on the computer if the sounds were the same or different (the screen shows a symbol with the word 'same' on one side of the computer and a symbol with the word 'different' on the other).

The Intonation and Prosody Output tasks assess the ability to imitate various prosodic forms presented with spoken (not laryngograph recordings) single words or phrases, respectively. The child is told to listen to the person on the computer and to copy what she says. The examiner judges the child's response and indicates on the keypad if it is good (a perfect echo of the intonation, worth 1 point), fair (not an exact imitation but the function of the utterance was maintained in the intonation, worth .5 point), or poor (incorrect imitation that did not maintain the function of the intonation, 0 points).

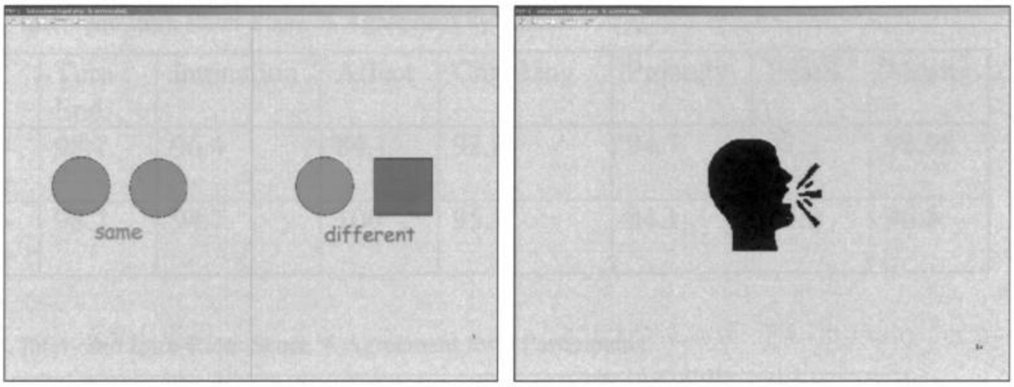


Figure 3-6. Computer Screen-Shots of Form Input and Output Tasks; for the Input task (left) the child must choose the picture that indicates if two sounds were the same or different; for the Output task (right) the child repeats a word or phrase spoken by the computer

3.1.5.6 PEPS-C Scoring

The PEPS-C yields raw scores for both receptive and expressive prosodic skills, as well as a raw score total for the entire assessment. The PEPS-C programme has a computerized scoring feature that provides an item-by-item summary sheet, subtest and total scores. Based on the design of the PEPS-C, each of the input tasks provides a binary choice for responses; therefore the pass-criterion is 75% (12 or more correct out of 16) (Peppé & McCann, 2003). The pass-criterion is the same for the output tasks; however, as noted they require the tester to rate responses as correct, incorrect, or ambiguous, and rely on perceptual judgments. Therefore inter- and intra-rater reliability checks were undertaken to ensure the ratings made by this examiner were consistent. Six participants (25%) were identified using a numeric randomisation within the Microsoft Excel program and all their expressive (output) subtests were re-scored by this examiner (intra-rater) and by a researcher with extensive experience using and scoring the PEPS-C (inter-rater). Percentages of agreement were then calculated. These ratings are delineated in Tables 3-2 and 3-3. Both inter- and intra- rater agreements are good, as evidenced by the comparison to findings from recent studies, presented in Table 3-4.

Table 3-2. Inter- and Intra-Rater Score % Agreement by Subtest

	Turn-End	Intonation	Affect	Chunking	Prosody	Focus	Mean
Inter-Rater	98.7	96.4	84.1	92.8	94.7	97.2	93.98
Intra-Rater	98.7	94.7	100	95.7	94.1	95.8	96.5

Table 3-3. Inter- and Intra-Rater Score % Agreement for 6 Participants

	01	15	16	23	27	30	Mean
Inter-Rater	98.8	96.8	82.6	96.3	97.5	97.1	94.9
Intra-Rater	97.1	97.8	96.4	97.0	99.3	99.4	97.8

Table 3-4.Comparison of Current Reliability Scores with Those from Previous Studies

Researcher	Mean Reliability	Range	Type of Rater/ % of data analysed	Measure
Carroll	96.5	94.1 - 100	Intra / 25%	Peps-C
Carroll	93.98	84.1 - 98.7	Inter / 25%	Peps-C
Peppé et al. (in press)	88.3 %	Min 78.7	Inter / 10%	Peps-C
Paul et al. (2005)	90%	82.3 – 99.6%	Inter / 25% TD /100% ASD	Author's assessment

3.1.5.7 Subjective Judgments of Presence vs. Absence of Atypical Expressive Prosody

The PEPS-C provides levels of ability for the understanding and use of prosody within highly structured tasks. However, it does not assess prosodic ability in naturalistic, functional occurrences within spontaneous speech. Children with HFA are frequently noted to have odd or unusual expressive prosody (Simmons & Baltaxe, 1975; Baltaxe & Simmons, 1985; Paul & Sutherland, 2005) in their spontaneous speech. Therefore, a subjective assessment noting the presence or absence of atypical expressive prosody was made for each of the participants, based on all spontaneous conversation between the examiner and the child, as well as those between family members and the child at both Time points. At Time point 1, the judgments were made by a certified speech and language therapist/researcher on the CSO project and at Time point 2, the judgments were made by the author of the current study. At Time point 2, this examiner remained blind to the subjective judgments from Time point 1 until after the Time point 2 judgments were made. Agreement was 100% across the two Time points in the ratings for 23 children with HFA (judgment could not be made at Time point 2 for one participant due to his limited expressive output). At Time point 2, this examiner also made a subjective judgment about the type of atypical expressive prosody (monotonous or exaggerated).

Although the subjective judgments were not confirmed by any acoustic analysis, they complement the more quantifiable information from the PEPS-C. At both Time points, subjective judgments were made by examiners who are experienced speech and language clinicians and, as such, are trained to perceive normal and abnormal speech, including parameters of articulation/phonology, voice, fluency, resonance and prosody. Often such judgments lead to preliminary diagnosis of speech differences that may or may not warrant additional assessment (Duffy, 2005). Additionally, the speech and language therapists at both Time points had extensive experience working with children with ASDs. Inclusion of subjective judgments adds critical information about the use of prosody in functional contexts (RCSLT, 2005). When considered in combination with information about prosody in structured contexts from the PEPS-C, a fuller picture of prosodic ability should emerge for each individual.

3.1.6 Change of Assessment Measures at Time Point 2

Refer to Table 3-1 (p. 74) for the full list of tests administered at the both Time points. At Time point 2, unless otherwise noted, all assessments were the same as at Time point 1. This was done to address one of the major aims for this study; to understand the nature of language and prosodic skill development over time. The battery was able to be completed by almost all the participants at Time point 1 and the most detailed and specific observations of stability and change over time could be obtained by repeating these same measures. There were, however, some changes to the test battery: inclusion of an expressive vocabulary measure and administration of newer, updated versions of the TROG and CCC. These will each be discussed in turn. Also, the Goldman-Fristoe Test of Articulation was only administered at Time point 2 if the child had one or more errors at Time point 1. However, informal assessment of single-word speech production was conducted during the first testing session to ensure there were no speech errors.

3.1.6.1 Expressive Vocabulary

The Expressive One-Word Picture Vocabulary Test, Revised (EOWPVT-R) (Brownell, 2000) was used to measure expressive vocabulary in single-words. In addition to word knowledge as assessed via receptive vocabulary tests, expressive vocabulary assesses the ability to retrieve the word from memory. Furthermore, similarities and differences between receptive and expressive vocabulary scores are important in the overall language assessment of a child and can yield diagnostic information about word-retrieval skills and deficits. The EOWPVT-R utilises coloured pictures and the child is instructed to name the picture. Prompts are given to remind the child to use a single word and also to elicit a more specific response when required. For example, when shown a picture of a dog, if the child says 'animal' the examiner prompts a more specific response by asking 'what kind?' The test yields a standard score, age equivalent and percentile rank. The EOWPVT-R was standardised on normative data from American children; additionally, some of the specific word labels the test attempts to elicit are labelled differently by Scottish children (e.g., wrench/spanner).

3.1.6.2 Receptive Grammar

Receptive grammar was assessed with Bishop's (2003a) Test for Reception of Grammar, Version 2 (TROG-2). This version was revised and included new, professionally drawn illustrations and updated normative data. As the scores are standardised in both versions, it was expected that there would be no difficulty in comparing the standardised scores in this version with the earlier one; however raw scores would not be able to be compared. As with the earlier version, the examiner administering the TROG-2 makes statements of increasing grammatical complexity and the child points to one of four possible pictures that best matches the statement spoken by the examiner.

3.1.6.3 Pragmatics

Pragmatic skills were assessed using Bishop's (2003b) Children's Communication Checklist, 2nd Edition (CCC-2). The original version was not standardised, however the second edition includes normative data and finer distinctions to delineate the communicative behaviour of individuals with autistic spectrum disorders. Changing to this newer version is problematic in that many of the questionnaire items are different and at Time point 1 the CCC was completed by either the child's teacher or speech language therapist and at Time point 2 the CCC-2 was completed by the child's parents. Therefore no direct comparison between versions of the CCC can be made or assumed. However, because it is now a standardised assessment tool, results can be compared to other measures given at Time point 2. For this reason in particular, it was decided that the newer version would be more useful in measuring the pragmatic ability of this cohort.

3.1.6.4 Scoring of Language Assessments

Each assessment measure was scored using the specific guidelines listed in each assessment tool's published manual. The criteria chosen to determine if a child's score was indicative of impairment is standard scores falling 1.5 or more standard deviations (below a score of 77.5 where the mean is 100) below the population average (Spaulding, Plante & Farinella, 2006) for individual assessments. The CCC-2 was scored with a computerised scoring tool that came with the assessment and impairment criteria were scale scores that fell below 6 (Bishop, 2003b).

3.1.6.5 Theory of Mind Battery

To measure ToM skills, a battery of commonly used first- and second-order false-belief tasks and a more recently developed scale that assesses early ToM understanding were administered. Recent research reviews have cited the need for a more comprehensive assessment of ToM skills, rather than simply a single measure of false-belief tasks (Wellman et al., 2001; Wellman & Liu, 2004). In addition, there is concern regarding the language and grammatical content within ToM tasks which may affect outcome and may or may not reflect ToM understanding but rather, perhaps, language and grammatical skill development (Sullivan, Zaitchik & Tager-Flusberg, 1994; de Villiers & de Villiers, 2003; Fisher et al., 2005; Tager-Flusberg & Joseph, 2005), as discussed in Chapter 2.

The significant delay or absence of acquisition of false-belief understanding is well-documented among the majority of individuals with ASDs (Baron-Cohen et al., 1985; Baron-Cohen, 1989; Perner, Frith, Leslie & Leekam, 1989; Happé, 1995).

However, the developmental progression of skills that occurs before false-belief understanding is acquired has not been studied extensively. Information from such a progression would elucidate what, if any, steps toward false-belief understanding have been made. Additionally, some individuals with ASDs have been noted to develop ToM skills in a more typical timeline (Bauminger & Kasari, 1999; Rutherford et al., 2002; Silliman et al., 2003; Kremer-Sadlik, 2004), particularly those with HFA and Asperger syndrome. Therefore, second-order tasks were included as well to determine the upper level of skills that may have developed.

The widely used second-order John & Mary task (Perner & Wimmer, 1985; Baron-Cohen, 1989; Sullivan et al., 1994; Bauminger & Kasari, 1999; Muris et al., 1999) has a great deal of published data on the outcome for typically developing children and those with HFA, as discussed in Chapter 2 (Section 2.3.4.4, pp. 58-60). However, Sullivan et al. (1994) noted that the John & Mary task has heavy demands on language and information-processing that might overshadow actual performance on the ToM questions. Therefore, another second-order task, called the Chocolate Story (Sullivan et al., 1994; Hughes et al., 2000), which is a modified version of the John & Mary story and linguistically simplified by reducing the story length, was added to the ToM battery. Table 3-5 lists each of the ToM tasks used in the assessment battery, with references to relevant research publications.

Table 3-5. References for Published Normative Data for Theory of Mind Tasks

ToM Measure	**Reported with developmental norms in:**
Theory of Mind Scale	Wellman & Liu, 2004 Peterson, Wellman & Liu, 2005
'Smarties' False-Belief	Perner et al., 1987 Muris et al., 1999 Hughes et al., 2000
'Chocolate Story' second-order False-Belief	Sullivan et al., 1994 Hughes et al., 2000
'John & Mary' second-order False-Belief	Perner & Wimmer, 1985 Baron-Cohen, 1989 Sullivan et al., 1994 Bauminger & Kasari, 1999 Muris et al., 1999

3.1.6.6 ToM Scoring

Each of the ToM tasks has normative data from previous research studies. These tasks were scored in the following manner. One point was awarded for each task that was passed within the battery, following criteria used in the published reports. Hughes et al. (2000) found that reliability was improved through the use of multiple false-belief task measures. In addition to individual scores for each measure, scores were combined to make a more robust aggregate score (Hughes et al., 2000; Hale & Tager-Flusberg, 2005). If every ToM task was passed, the highest possible score would be eight. The score sheets for all tasks are presented in Appendix VII (pp. 258-259).

3.1.7 Theory of Mind Tasks

As discussed in Chapter 2, previous research indicates that task variables in ToM assessments may significantly affect performance and potentially jeopardise the reliability of results. Therefore, task selection and variables within each task were considered in great detail.

3.1.7.1 First-Order Task

Each of the ToM tasks will be described in turn, with the complete scripts available in Appendices IV, V and VI (pp. 251-257). For the Smarties task, the child is shown a picture of a Smarties sweet container and asked what he or she expects would be in the box. Then the child sees that instead of sweets, it contains a pencil. The child is asked to state what another person, who did not see inside the container, would think was inside. Finally the child is asked to recall that there is a pencil inside the container.

3.1.7.2 The ToM Scale

The ToM Scale (Wellman & Liu, 2004) is comprised of five tasks adapted from earlier studies; the first is Diverse Desire which assesses the child's understanding that two different people can have different desires about the same two objects. The child is shown pictures of two snacks and asked to name which snack he or she likes best. Then the child is introduced to Mr. Jones and told that he prefers the other snack (whichever the child has not chosen). Then the child is told Mr. Jones can only choose one snack and is asked to name which one Mr. Jones would choose.

The next task is called Diverse Belief which assesses whether the child understands that two different people can have different beliefs about the same two objects, even though the child does not really know which belief is true. The narrator explains that Linda has lost her cat and that it is hiding in one of two locations. The child is asked in which of the two locations he or she would look for the cat and is then told that Linda thinks her cat is in the other location (again, whichever location the child did not name); then the child is asked to tell where he or she thinks Linda will look for the cat. Figure 3-7 illustrates the Diverse Desire and Diverse Belief tasks.

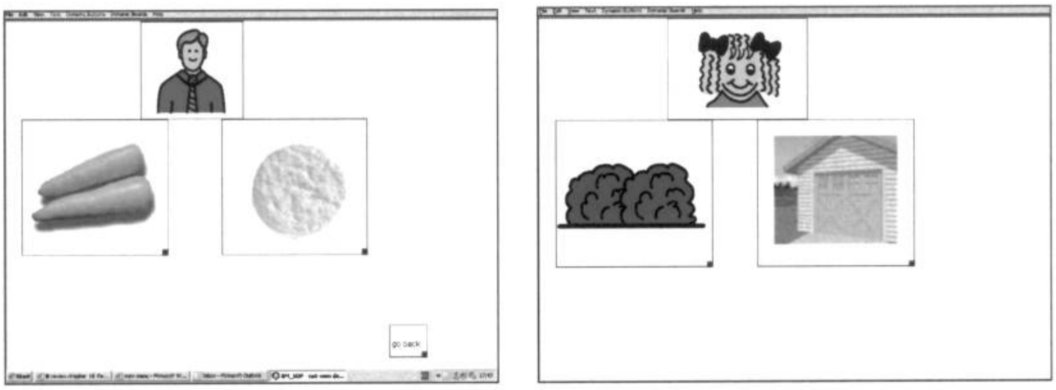


Figure 3-7. Computer Screen-Shot of Diverse Desire and Diverse Belief Tasks; for Diverse Desire (left) the child chooses the snack he/she thinks the man will want; for Diverse Belief (right) the child chooses the location he/she thinks the girl will look for her lost cat

The third task in the ToM scale is Knowledge Access and it assesses whether the child understands that a person who has not looked inside a container would not be able to know what was inside. The child is shown a picture of a dresser drawer and is asked to make a guess about the contents of the drawer (e.g., socks or clothing). The next picture shows the open drawer with a highly unlikely object inside (a dog). The child must then recall that there is a dog in the drawer. The child is told that Polly has never seen inside the drawer. Lastly, the child is asked to recall if Polly has seen inside the drawer and whether or not Polly knows what is in the drawer.

The fourth task is Contents False-Belief which assesses whether someone who has not seen an unusual object inside a container would think it contains the ordinary object or the unusual object. The child is shown a plaster box (band aids) and asked what he or she thinks is inside and is then shown that there is a pig inside the container. After the child is asked to recall what is in the container, the child hears that Peter has never seen inside the container. Finally, the child is asked to identify which object Peter will think is in the plaster box. This task is almost identical to the Smarties task; however in Contents False-Belief the child is explicitly asked to recall that the other person did not see inside the container. Figures 3-8 and 3-9 illustrate Knowledge Access and Contents False-Belief tasks.

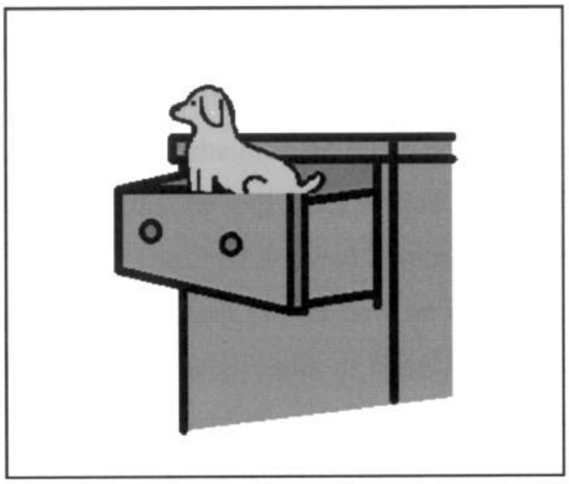


Figure 3-8. Computer Screen-Shot of Knowledge Access Task; the child sees that there is a dog in the dresser drawer

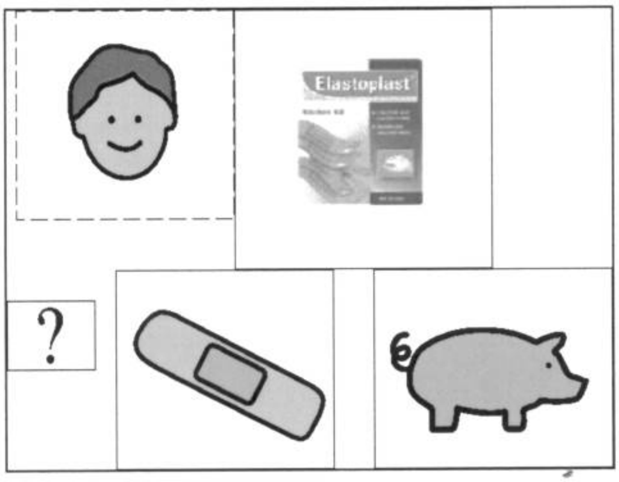


Figure 3-9. Computer Screen-Shot of Contents False-Belief Task; the child chooses the item (plaster or pig) that the boy will guess is in the plaster box.

The fifth and final task in the ToM scale is Hidden Emotion which assesses whether or not the child understands that a person can feel one emotion internally while at the same time convey a different emotion on his or her face. The child is told that he or she will hear a story about a boy in which the boy might feel happy, sad, or okay, and is shown a photograph of the back of a boy's head and symbols representing each of the three emotions, see Figure 3-10. A comprehension check is administered in which the child is asked to point to each of the three symbols. The child is then told that he or she will be asked to tell how the boy (Matt) feels and that Matt may feel the same inside as the way he looks on his face, or that Matt may actually feel different from how he looks on his face. The story explains that Matt's aunt came home from a trip and although she had promised to bring Matt a toy car, she brought him a book instead. The child is told that Matt doesn't like books and that he will have to hide how he feels or else the aunt will never bring another present. The child is asked to recall 1) what the aunt bought for Matt; 2) what will happen if Matt's aunt knows how he really feels and 3) how Matt really felt about receiving the book: happy, sad, or okay. Finally the child is asked to tell how Matt tried to look on his face and given the same three emotions as choices. To pass this task, the child has to indicate that Matt's inner emotion is more negative than his expressed emotion. Either of the following responses would be correct: 1) Matt felt sad about the book but tried to look okay or happy on his face, or 2) Matt felt okay about the book but tried to look happy.

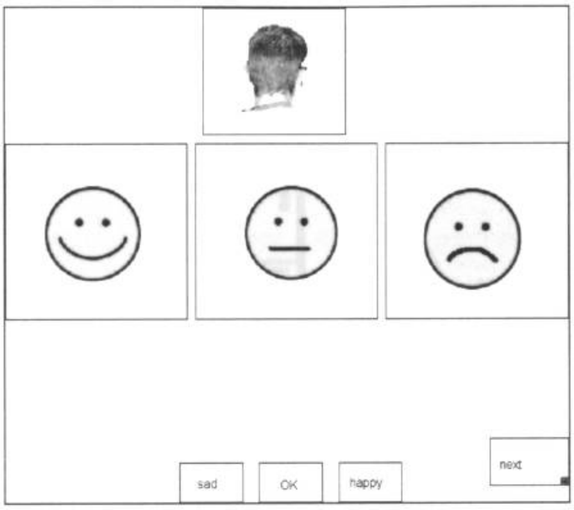


Figure 3-10. Computer Screen-Shot of Hidden Emotion Task; the child is shown icons that depict the emotions happy (left), sad (right) and okay (centre)

3.1.7.3 Second-Order Tasks

In the second-order tasks, the child is asked what one character thinks the other character will think or do. In the Chocolate story (see Figure 3-11) the child learns that Anne and Simon have been given chocolate to share and are told to put it in the refrigerator until their mother tells them they can eat it. They put it in the refrigerator and go out to play; Simon comes in alone and takes the chocolate out of the refrigerator and puts it in his bag. The child is told that Anne was watching Simon from the window and that she saw him put the chocolate in his bag. Simon goes back out to play and later both Anne and Simon are called into the kitchen and told they can have their chocolate. The child is asked 1) where Simon thinks Anne will look for the chocolate, 2) why Simon thinks that, 3) where the chocolate really is, and 4) where the chocolate was at the beginning of the story. All memory questions have to be answered correctly and the 'why' question has to include one of the following rationales: Simon doesn't know that Anne knows he moved the chocolate; or Simon thinks that Anne thinks the chocolate is in the fridge.

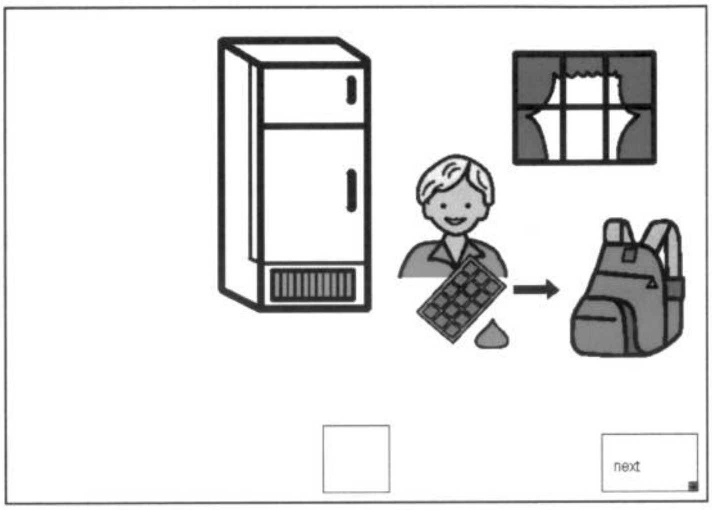


Figure 3-11. Computer Screen-Shot of Chocolate Story Task; 'Simon' takes the chocolate bar out of the refrigerator and puts it into his bag

For the John & Mary task, the child is introduced to the eponymous characters at the park in their village. Figure 3-14 (p. 98) presents a photograph of the props used for this task. The children's homes, the park and the church are labelled for the child. The entire John & Mary task was described in detail in Chapter 2, Section 2.3.1 (p. 51). At the end of the story, the child is then asked to tell 1) where Mary thinks John has gone to buy an ice-cream and 2) why. To pass this task, the child must answer 'park' and give a rationale that includes Mary's naïve information (Mary thinks that John thinks the ice-cream man is still in the park or Mary doesn't know that John knows the ice-cream man is at the church).

3.1.8 ToM Task Presentation Methods

The ToM tasks as described in the research articles listed in Table 3-2 (p. 88) were originally presented with props, real objects, puppets or pictures. In all cases, the accompanying stories, narratives and questions were presented live by a researcher from the referenced study. In order to present the ToM task battery in the most cohesive way possible for the present study, some changes and modifications were made. A major consideration for the design included the need for the narratives to be recorded and presented by a speaker of Edinburgh Scottish-English (ESE), as the participants were speakers of ESE (the author of the current study is a speaker of American English). Furthermore, use of recorded narrative assured consistency in presentation of the narratives to all participants.

Therefore, considered options for combining recorded narrative with props and/or pictures were 1) to record and present a video of each task being presented with pictures or props by a native ESE speaker; 2) to record narratives and questions on audio by a native ESE speaker and have this examiner demonstrate movement of props and pictures; 3) to record narratives and questions on audio by a native ESE speaker and have this examiner present the tasks using picture symbols in software with specially designed activities on a laptop computer; 4) to record narratives and questions on audio by a native ESE speaker and have this examiner present most of the tasks with specially designed activities on computer software, and use live props manipulated by this examiner for the John & Mary task. The first three options were eliminated because it was determined through pilot testing with 5 typically developing children that: 1) use of video tape to stop and start each activity was unwieldy, especially if repetitions were needed; 2) using a recorded voice and a silent examiner manipulating pictures and props was felt to be possibly distracting and unnatural; 3) the John & Mary task became more complex when produced on the computer as the movements described in the narrative were not able to be shown as explicitly with static pictures as opposed to props. Therefore, computer activities with picture symbols and a live prop set for the John & Mary story were designed which incorporated recorded narratives and questions by a speaker of ESE. In a comprehensive meta-analysis of false-belief testing, Wellman et al. (2001) concluded that there were no effective differences in results when comparing tasks presented via use of storybooks, video, pictures, puppets, or props to assess false-belief understanding, as long as there was consistency within each task (all props, all real objects, all pictures, etc.).

3.1.8.1 Computer Interface

An important consideration in the design of the tasks for computer was ease and accessibility for this examiner to interface between activities as quickly as possible, as well as flexibility to repeat narratives or questions when needed without delay. The program Speaking Dynamically Pro (© 1981-2006 by Mayer-Johnson LLC, All Rights Reserved Worldwide, Used with permission) was used to create a set of interacting dynamic display files with each of the individual ToM tasks visually represented by picture symbols on a main menu page. Each picture symbol then links to and opens the specific file that assesses that ToM task. Dynamic display is similar to technology used on an internet webpage with links leading away from and back to a main site or page. It was a useful feature for the ToM scale, because with the Diverse Desire and Diverse Belief tasks, the child is asked to choose between two pictures at the beginning of the task, with each choice requiring a different narrated response. Therefore, the second part of the task required flexibility to accommodate the two response choices. The computer software was programmed to default to choose the opposite item, thus presenting the task in the same manner as detailed by Wellman and Liu (2004). Within each ToM task there are further links to present the information with all prompts, narratives and questions as had been done in the original study. At the end of each task, another link brings the examiner back to the main menu to begin another task or to end the testing session. Figure 3-12 illustrates the menu page that links between all tasks.

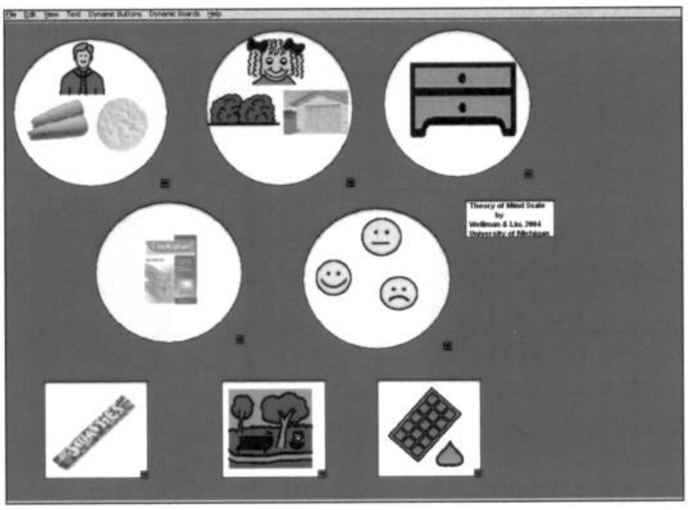


Figure 3-12. Computer Screen-Shot of ToM Task Main Menu; the examiner uses this menu to manoeuvre between ToM tasks

3.1.8.2 Adaptation of Language

For some of the ToM tasks, particular items needed to be changed or reworded to include more common Scottish terms or objects. For example, 'band-aid' was changed to 'plaster', 'mitten' was changed to 'glove', 'closet' was changed to 'cupboard' and 'cookie' was changed to 'biscuit'.

3.1.8.3 Use of Visuals

As noted, all of the original ToM tasks utilized pictures, objects, puppets or props. Except in the John & Mary story, all previously used pictures and objects needed to be adequately represented pictorially for use on the computer without sacrificing clarity or salience. Boardmaker software (© 1981-2006 by Mayer-Johnson LLC, All Rights Reserved Worldwide, Used with permission.) picture symbols were used to replace most of the visuals. Boardmaker has a variety of colour picture symbols to represent generic children and adults; several were selected to represent the characters in the stories. The pictures were all approximately 3" square when viewed on the laptop screen. Boardmaker has an extensive library so the pictures were consistent in style and quality. In addition, permission was sought and granted by Mayer-Johnson to use the symbols in any subsequent presentations and/or publications. 3" square electronic copies of real photographs (carrot, biscuit, back of a boy's head) were used where there was not a suitable Boardmaker symbol; see Figure 3-13 for an example.

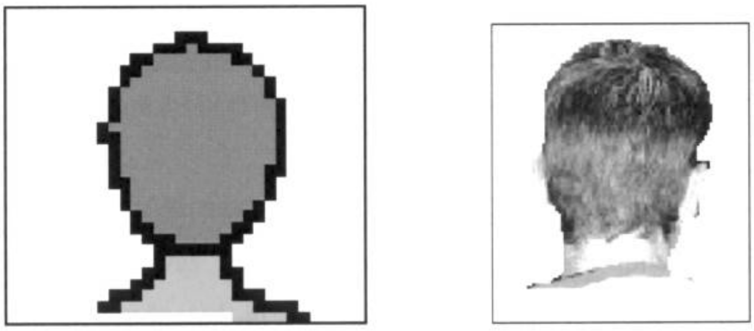


Figure 3-13. Comparison of Clarity of Boardmaker Symbol (left) versus a Photograph (right); the photograph was chosen to represent the back of a boy's head

As discussed, the John & Mary task was potentially the more linguistically complex of the second-order tasks and, due to several changes in locations by the characters, the story was difficult to represent visually with static pictures as they are unable to demonstrate movement between locations. Therefore, a live set was constructed following the specifications listed by Baron-Cohen (1989), see Figure 3-14. On a 24" x 24" base, props were used to symbolise a park with trees, a church, and two individual houses. Small toys were used for the characters and a toy postal van was transformed into an ice-cream van with pictures of ice-cream on its sides. The audio for the story was recorded and narratives and questions were added into Speaking Dynamically Pro individually where they could be quickly accessed and repeated if necessary.

Figure 3-14. Photograph Depicting Props used for 'John & Mary' ToM Task

3.1.8.4 Recording of Narratives

A speaker of ESE was recruited to record the narrations for all the ToM tasks. Recording was conducted in the speech laboratory sound treated room at Queen Margaret University College, using a Marantz CDR300 recorder with a Beyer MCP65 microphone. The audio files were extracted using Adobe Audition v.1.0 and edited into phrase or sentence length chunks using the software program Syntillium Cool Edit '96 and then saved as a Windows Wave (wav) file format. Each wav file was then labelled, copied and pasted into the Speaking Dynamically Pro software. When the editing was complete, the program was presented to two experienced speech and language therapists who indicated that, on portions of the audio recording, the rate of speech was too rapid. Those narratives were then re-recorded at a slower rate.

3.2 DATA COLLECTION

In the following sections, information on ethical approval and subject recruitment will be presented. As noted at the beginning of this chapter, the data from Time point 1 was part of a separate study funded by the Scottish Executive Chief Scientist Office (CSO).

3.2.1 Time Point 1

3.2.1.1 Diagnosis of Autism

The children had been diagnosed with autism as the result of a multidisciplinary assessment based on ICD-10 (World Health Organisation, 1992) or DSM-IV criteria (American Psychiatric Association, 1994) as well as by a range of additional diagnostic measures including: Childhood Autism Rating Scale (DiLalla & Rogers, 1994), Gilliam Autism Rating Scale (Gilliam, 1995) and Autism Diagnostic Observation Schedule (Lord et al., 2000). Diagnosis was confirmed by a specialist consultant paediatrician (the 4th author on the CSO study). The diagnostic assessment process also included evaluation of communication, level of reciprocal social interaction and repetitive behaviours. Additionally, children were assessed on their ability to attend to and imitate various stimuli, comprehension and use of language, as well as their level of play skills. Children with a diagnosis of Asperger syndrome were not included in this study.

3.2.1.2 Ethical Approval and Inclusion Criteria

At Time point 1, the CSO study team submitted and received ethical approval from the City of Edinburgh Education Department, the National Health Service, University of Edinburgh and Queen Margaret University College. For the individuals with HFA, entry criteria included: diagnosis of autism, evidence of an early delay in speech and language development and normal non-verbal cognitive ability. Some, but not all of the children identified had previously been tested with Raven's Progressive Matrices (Raven et al., 1986) to confirm that non-verbal cognitive skills were within the normal range (standard scores > 70). Other children were identified by the specialist consultant paediatrician as being likely to have non-verbal cognitive skills, based on a review of the case notes. However, children would have been excluded from the study if non-verbal cognitive scores were below a standard score of 70 (see section 3.2.1.3). Typically developing children were used as a control group and were matched on verbal mental age as determined by the BPVS test of receptive vocabulary (Dunn et al., 1997), socioeconomic status as determined by the Carstairs Deprivation Category (Carstairs & Morris, 1991), and sex.

3.2.1.3 Exclusion Criteria

Children were excluded from both groups due to any of the following criteria: 1) English was not the child's first language and primary language of the home; 2) history or evidence of binaural hearing loss; 3) receptive language skills less than 4 years (as measured by receptive vocabulary); 4) non-verbal cognitive scores below 70 on Raven's Progressive Matrices (Raven et al., 1986); 5) evidence or history of a major physical disability or vocal tract structural abnormality; or 6) resident in Scotland for less than three years. In addition, children were excluded from the control group if there was a history or evidence of speech, language, or cognitive impairment or delay.

3.2.1.4 Recruitment of Children with HFA

The potential participants for the HFA group were identified by the consultant paediatrician who sent a letter to the families introducing the aims and content of the study. An information sheet was included that detailed the rationales and procedures to be undertaken, with a photograph of the clinic assessment room so the child would understand what to expect. A consent form was also included which highlighted that parents could choose to participate with or without also consenting to audio and videotaping. In addition, assurances were made that all data would be made anonymous and that any participant could choose to withdraw from the study at any time and for any reason. A further consent was obtained requesting the ability of the research team to use audio and video (if these permissions were granted by the family) for educational purposes. Following these documents in the mail, a phone call was made approximately two weeks later by a research assistant to inquire if the family was interested in participating. If so, scheduling of the participant was done at that time. Testing was conducted over two one-hour sessions and took place at a Speech and Language clinic for most of the children; however some of the families chose to have their child tested in their own homes.

3.2.1.5 Recruitment of Children with TD

Recruitment of the TD children took place after testing of the children with HFA, as scores on the BPVS were not known until that time. TD and HFA children were matched on verbal mental age as measured by the BPVS. Once a child with HFA had completed testing, and the verbal mental age was known, a school in the same postcode as the child with HFA was identified. The Head Teacher of that school was contacted through the mail, again with an introductory letter and specific details of what the testing entailed. If the Head Teacher agreed for his/her school to participate, he/she identified two to four typically developing children of the age range that matched the child with HFA and letters were forwarded to the TD child's family. They received the same documents indicating details of testing, ability to withdraw and permission for audio and videotaping. Families were given a choice as to whether they preferred their child to be seen at their own school or at the Speech and Language Clinic at Queen Margaret University College. Further, the parents could choose to be present at the time of testing. All assessment measures were administered by a certified speech and language therapist.

3.2.1.6 Participant Details

The group of children with HFA was comprised of 31 children aged 6 to 13 years (mean age 9.75 years). There were 25 boys and 6 girls. There were 72 children recruited for the control group, aged 4 to 11 years (mean age 6.9 years) and included 54 boys and 18 girls. Ultimately, four children were excluded from the control group due to BPVS scores that fell below 4 years (McCann et al., in press).

3.2.2 Ethical Approval and Inclusion Criteria – Time Point 2

Applications for ethical approval were granted by the City of Edinburgh Education Department, the National Health Service, University of Edinburgh and Queen Margaret University College. Once all the ethical approvals were granted, the CSO research team provided a list of names for all the families of children with HFA who had participated at Time point 1. All the inclusion and exclusion criteria continued to be met and all the families were contacted in due course.

3.2.2.1 Recruitment of Children with HFA

The consultant paediatrician (also the 4^{th} author on the CSO study and an advisor on the current study) who identified the children with HFA at Time point 1 (hereafter referred to as HFA-T1) signed a letter to all the families who had participated previously, introducing the aims and content of the current study. An updated information sheet was included that detailed the rationales and procedures to be undertaken, with another photograph of the clinic assessment room so the child would understand and perhaps remember what to expect; a copy of the information sheet is included in Appendix I (pp. 241-243). As at Time point 1, a consent form was also included which highlighted the options for consent with or without videotape, assurances for anonymity and withdrawal from the study at any time. Following a recommendation by the ethics committee, a second consent form was written for those participants who would be over the age of 14 years at the time of testing. Copies of both consent forms are presented in Appendix II (pp. 244-247). Following these documents in the mail, a phone call was made approximately two weeks later to inquire if the family and the individual were interested in participating. If so, scheduling of the participant was done at that time. Testing was conducted over six months in 2005.

3.2.2.2 Data from TD Group

The control group of TD children at Time point 2 (hereafter referred to as TD-T2) consisted of TD data gathered at Time point 1 (hereafter referred to as TD-T1). After testing of the HFA group at Time point 2 was completed, a control group was assembled by matching each individual by sex and Time point 2 verbal mental age scores within one month to one of the original 72 TD children tested. They were also matched as closely as possible on socioeconomic status as measured by the Carstairs Deprivation Category (Carstairs & Morris, 1991); though this was not always feasible with the available data. However, Black, Peppé and Gibbon (2006) analysed the TD-T1 data and found no correlation between BPVS scores and Carstairs Deprivation Categories.

3.2.2.3 Participant Details

The HFA group at Time point 2 (hereafter denoted as HFA-T2) was comprised of 24 of the original cohort of 31 children (77%). Seven families chose not to participate at Time point 2 for the following reasons: four families stated that their child did not want to participate, two families never responded to letters or phone messages and one family scheduled sessions but did not attend and did not respond to a follow up letter or phone calls. The children with HFA-T2 who did take part were aged 8 to 16 years (mean age 11.91). There were 18 boys and 6 girls. The TD-T2 group's mean chronological age was 7.47 and ranged from 4.83 to 14.67 years. The Mann-Whitney test (2-tailed, exact, $z = -.237$, $p = .818$) confirmed there was no significant difference between the TD-T2 and HFA-T2 groups' BPVS age equivalent scores (HFA *M* 8.22, *SD* 2.82; TD *M* 8.16, *SD* 2.78).

3.2.2.4 Time Elapsed from Time Point 1

The families of children with HFA were contacted in approximately the same order at Time point 2 as they were at Time point 1. It was anticipated that by doing so, the amount of time between 1 and 2 would be as similar as possible. Ultimately, the mean amount of time between the two time points was 2.25 years, SD .29, with a range from 1.5 years to 2.58 years.

3.2.3 Administration of Assessments

HFA-T2 testing was conducted over two sessions and ethical approval allowed for 90 minutes each time. However, only the first session actually lasted for 90 minutes and the second session ranged from 45 to 75 minutes, depending on how long the children took to complete the assessments. The most able children generally had the longer sessions. Two of the children required additional sessions; one became ill during the second session and required a third session; and the other child was seen over four 35 minute sessions (decided jointly by parent and examiner) due to his limited attention level.

Most participants completed their sessions within a single two-week period and all completed their sessions within a single month. Families of the children with HFA were given an option to participate in this study either at the Speech and Language Clinic at Queen Margaret University College or within their own homes. Eight were tested in their homes (33.3%), 15 were tested in the Speech and Language Clinic (62.5%) and one child (4.2%) was seen at home for the first session, then in the clinic for the follow-up session.

Table 3-6. Order, Timing and Mode of Tests Administered

Session 1 Task Order - Total 90 minutes	**Average Amount of Time to Administer**	**Mode of presentation**
Second-Order Theory of mind 'John & Mary'	5 minutes	Live props
First-Order 'Smarties' task	1 minute	Computer
Theory of mind scale	6 minutes	Computer
Second-Order Theory of mind 'Chocolate story'	3 minutes	Computer
Goldman-Fristoe Test of Articulation II (GF) (if child had errors at Time point 1)	10 minutes	Paper assessment
Expressive One-Word Picture Vocabulary Test, Revised (EOWPVT-R)	10-15 minutes	Paper assessment
Profiling Elements of Prosodic Systems for Children (PEPS-C)	45-60 minutes	Computer
Test for Reception of Grammar 2nd Edition (TROG-2) (if time allowed)	20 minutes	Paper assessment
Session 2 Task Order – Total 45 to 60 minutes		
Clinical Evaluation of Language Fundamentals-3, U.K. Version (CELF 3-U.K.) Expressive Subtests	10-25 minutes	Paper assessment
Test for Reception of Grammar 2nd Edition (TROG-2) (if there hadn't been time in session 1)	20 minutes	Paper assessment
British Picture Vocabulary Scale 2nd Edition (BPVS)	15 minutes	Paper assessment
Raven's Progressive Matrices (RPM)	7 minutes	Paper assessment

3.2.3.1 Order of Tasks – Overview

Parents were given the choice to observe the testing sessions and to have siblings present if they desired. The tasks were presented in the same order to all of the participants, with exceptions as noted. Time constraint was a major factor in the task order. As noted above, the children were scheduled for two 90-minute sessions; therefore each individual session was a potentially challenging length of time for the children to remain focused on tasks while hopefully also performing to the best of their ability. Thus, the design of the task order was for efficiency; for example, all computer tasks were given in the same session. As noted in Table 3-6, the CCC-2 questionnaire was given to and completed by a parent. Some parents chose to complete the questionnaire during the first session and some took it away and returned it at the follow-up session.

3.2.3.2 Session One

The John & Mary ToM task was given first because the story's props had been assembled before the child's arrival (if tested at the clinic) or while introductions were being made with the families (if tested in the family home). It was assumed that the props would be appealing and gain the interest of the participant and, until they were put away, they were potentially going to be distracting as well. So the plan was to administer the John & Mary task first, let the child play with the props for a few minutes afterwards as the set got put away out of sight and then continue with the rest of testing. It is, however, the most difficult of the ToM tasks so the possible effects of this order rationale will be raised in the discussion section. For continuity, the remaining ToM tasks were then presented in the following order: Smarties task, ToM scale, then the Chocolate Story.

The ToM scale had an additional order rationale based on the recommendation of Wellman and Liu (2004) who suggested the Diverse Desire and Hidden Emotion tasks consistently be presented first and last, respectively, while the three middle tasks should be given in various order. Therefore, three presentation orders were used within the ToM Scale (see Table 3-7) and these were used in a rotation based on scheduling; the first participant scheduled used order A, the second used order B, the third used order C, the fourth order A, and so on. Next, the GF (only administered if child had errors at Time point 1) and the EOWPVT-R were given; these were done to give the child a rest from computer tasks before the PEPS-C was administered. If there was time left and if the examiner deemed the child still working effectively based on behavioural indications such as maintained focus on tasks and pleasant demeanour, all or part of the TROG-2 was given.

Table 3-7. Presentation Orders for ToM Scale

Order A	Order B	Order C
1) Diverse Desire	1) Diverse Desire	1) Diverse Desire
2) Diverse Belief	2) Knowledge Access	2) Contents False Belief
3) Knowledge Access	3) Contents False Belief	3) Diverse Belief
4) Contents False Belief	4) Diverse Belief	4) Knowledge Access
5) Hidden Emotion	5) Hidden Emotion	5) Hidden Emotion

3.2.3.3 Session Two

For this session, assessments were planned so that the most potentially challenging test came first when the child had the most energy. Therefore the CELF expressive subtests were given first, followed by the TROG-2 (if all or part of it had not been completed in the first session), the BPVS, and finally the RPM, which was expected to be the easiest.

3.2.3.4 Use of Visual and Behavioural Supports

This examiner provided a pictorial or written schedule of activities to be done in each session so the participant knew what to expect and how many tasks were left. One was a written activity schedule and the other a visual activity schedule using Boardmaker symbols to represent activities. Both were prepared ahead of time and this examiner used the one deemed most appropriate after meeting and chatting with the participant. Many of the participants used a pencil to cross out, run a line through or tick the completed activity. Some of the younger participants chose to put a sticker on the activity list after an activity was completed. In addition, the schedules were modified during a session if necessary to meet the child's individual needs. For example, one participant wanted to know how many questions were in every activity, so a countdown chart was added to tick off each question as it was completed. A copy of a visual activity schedule is presented in Appendix IX (pp. 260-261).

3.2.3.5 Use of Praise, Breaks and Rewards

This examiner gave verbal praise and encouragement throughout both sessions. When families were observing, they provided additional verbal encouragement at their discretion. Short (1 to 2-minute) breaks were provided throughout each session as needed. This examiner kept a collection of manipulative items such as a silly noise maker, a hand held marble game, a squeezing object, coloured pencils and blank paper and provided them if and when a participant requested a break during testing. Water was available to drink throughout both sessions and this examiner encouraged standing and stretching halfway through each session. At the end of the second session, each participant was given a completion certificate (see Appendix X, p. 262) and a thank-you card with a £5 note.

3.2.4 Location of Testing

3.2.4.1 Clinic

When testing took place within the Speech and Language clinic, the room was prepared ahead of the child's arrival. The props for the John & Mary ToM task were placed on a table with chairs on opposite sides of the table, following the procedure as described by Baron-Cohen (1989). The child sat with the park on his/her right and the church on his/her left. The laptop computer, which was needed to activate the narrative, was placed next to this examiner. A Yamaha loud speaker, model MS 101, was placed on the table to the right of the child and the volume was adjusted to a comfortable loudness level as determined by this examiner. An audio recorder was placed on the left side of the table with a microphone placed on the table in front of the child. After the John & Mary task was finished, the task props were removed from the table and the laptop placed onto the table for administration of the other ToM tasks and the PEPS-C on the computer. For these assessments, this examiner was seated on the child's left and the laptop screen placed approximately 18" in front of the child. The rest of the assessments were administered with the examiner on the child's left side.

3.2.4.2 Participants' Homes

Nine children with HFA were assessed in their own home and thus there was a great deal of variation in the physical set up. If there was an available kitchen or dining room table, that was the preferred choice; secondly a small table set in front of a chair or sofa was used; and if neither of these options were available, testing was conducted on the floor. Seating arrangements were the same as noted above for the clinic.

3.2.5 Equipment

3.2.5.1 Computer

The PEPS-C and ToM battery were presented using a Compaq Model nx7010 laptop computer with a 14" diagonal screen set to 1024 x 768 pixel resolution and 32 bit colour.

3.2.5.2 Audio and Video Recording

Audio recording of each session was done using a Marantz Model PMD670 compact flash recorder with a Kingston 512MB compact flash card and a Beyerdynamic Opus 51 microphone plugged into the left channel of the recording device. Some of the sessions in the Speech and Language Clinic at Queen Margaret University College were also recorded on Sony HMP Hi8 video tape using a Sony Digital 8 Handycam model DCR-TRV120.

3.2.6 Assessment Reports

This examiner wrote a report to each participant's parent or guardian indicating the scores attained at both Time points, with a brief summary of the direction of change for each participant. An example of a report is provided in Appendix XIII (p. 289) and a sample score summary sheet is included in Appendix XVI (p. 290). A description of each assessment measure was also included in the report that was sent to the families (Appendix XII, pp. 287-288). Parents were encouraged to telephone with any questions about their child's results.

3.3 SUMMARY

In this chapter the rationales for the methodology used in this investigation have been described along with details about the assessments used and the data gathering process. References to the relevant literature that influenced decisions have been provided. In the following chapter, the results of this investigation will be presented.

4

Results

This chapter provides details of the data analysis methods and results, presented in four main sections. The first section provides an overview of statistical analyses procedures used. The second and most extensive section presents details of the data gathered from the HFA group at T2. In addition to HFA-T2 group and individual results, two new subgroups will be introduced and compared. The first group will be based on the presence and type of language impairment profiles found within the HFA-T2 group and the second on profiles based on the presence or absence of unusual expressive prosody. The third section presents the results gathered at T1 as part of the previously described CSO project and compares the results to those of T2. Finally, the fourth section reviews the results of the previously gathered TD data and compares results to the matched HFA-T2 group. The HFA results are presented in the same order as in previous chapters, thus language results are followed by results of the prosody assessment and then ToM. For the TD children, BPVS results are followed by prosody results (the only measures completed by this group). As in earlier chapters, non-verbal cognitive skill results are presented in the language section.

4.1 DATA ANALYSES

All raw data are analysed using the software program SPSS for Windows Release 13 (SPSS, Inc, 2004). Rasch analyses for ToM scale scores are conducted using WINSTEPS version 3.53 (Winsteps, 2001).

4.1.1 Significance Levels

The Alpha level of significance is set at $p \leq .05$; values slightly above the .05 level are reported as trends toward significance, to lessen the possibility of Type 2 errors.

Actual probability values are reported to allow readers to "use their own judgment in deciding whether or not the null hypothesis should be rejected" (Siegal & Castellan Jr., 1988, p. 9). In addition, Cohen's *r* effect sizes are provided for which the following effect sizes apply: small, .10; medium, .30; large, .50; very large, .70 (Cohen, 1988). The effect size statistic is "relatively independent of sample size, comparisons ... provide a direct method of examining the magnitude of the differences between groups on different tasks" (Dennis et al., 2001, p. 51).

4.1.2 Assumptions

An analysis of 104 dependent variables is undertaken using the Shapiro-Wilk test of normality to establish where parametric calculations can be used without violating the assumptions required. The Shapiro-Wilk test is appropriate for sample sizes less than 50 (Field, 2005) and yields exact significance values, with those greater than .05 indicating a normal distribution. 45% of the variables (n = 47) are normally distributed and 55% (n = 57) show a significant deviation from normal. Additionally, where a normal distribution does occur, the Levene test of homogeneity of variance is used to further determine if variability of scores is similar between groups; if not, equal variance can not be assumed and non-parametric tests are used (Pallant, 2005). Each individual analysis is therefore chosen based on whether or not the assumptions of normality and equal variances are upheld.

4.1.3 Choice of Statistical Tests

4.1.3.1 Means Testing – Non-Parametric Tests

Non-parametric comparisons across two independent groups are undertaken with the Kolmogorov-Smirnov test (2-tailed, exact), as it has the most power for sample sizes which are less than 25 (Field, 2005). Comparisons for three or more independent groups are done using the Kruskal-Wallis test, exact, due to its appropriateness with small sample sizes. Post-hoc comparisons use the Bonferroni correction to avoid an inflation of the Type I error rate and are calculated using the formula .05 ÷ number of tests run (Field, 2005).

Two related samples are compared using the Wilcoxon signed rank test (2-tailed, exact) which calculates the relative magnitude and direction of change. Comparisons for three or more related samples are undertaken with Friedman's ANOVA, exact, which is appropriate for use with small samples. Again, post-hoc tests are done with the Wilcoxon signed rank test and using the Bonferroni correction as described above (Field, 2005).

4.1.3.2 Means Testing – Parametric Tests

Where parametric tests can be used, paired-samples t-tests (2-tailed) are used to compare means for two different conditions and independent-samples t-tests (2-tailed) are used to compare means across two different groups.

4.1.3.3 Effect Sizes

Effect sizes (r) for significant Wilcoxon signed rank tests are calculated using the formula $r = z \div \sqrt{n}$ with n indicating total number of participants (Field, 2005, p. 532). Additionally, effect sizes for significant findings using the Kolmogorov-Smirnov test are calculated using the formula $r = Z \div \sqrt{n}$ with n indicating the total number of observations across groups (Field, 2005, p. 556) and finally, effect sizes for significant findings from paired-t tests are calculated with the formula $r = \sqrt{(t^2 \div [t^2 + df])}$ (Field, 2005, p. 294).

4.1.3.4 Correlations

Correlation analyses are undertaken with Spearman's rho which is appropriate to use when data have violated parametric assumptions (Field, 2005). Partial correlations undertaken in the SPSS programme use Pearson's product moment correlations; therefore, when used in this investigation, preliminary analyses will verify similarity between the Spearman and Pearson coefficients before partial correlations are run (King, LeBas & Spooner, 2000).

4.1.3.5 Rasch Analysis

A Rasch model "is a one-parameter logistic model for dichotomous items that estimates difficulty and person ability levels" (Wellman & Liu, 2004, p. 533). Rasch models can be used to develop assessments that give a total score based on a number of responses for which the sum implies that a person with a higher score is considered to have more of a uni-dimensional skill than someone with a lower score. This model was used by Wellman and Liu (2004) in the development of the ToM scale that is used in the current study and will therefore be used to compare findings across studies. Rasch statistics evaluate the likelihood that a person at a certain ability level on a particular construct will pass easier items on a scale and fail the more difficult ones.

4.1.3.6 Logistic Regression

Logistic regression is used with non-parametric variables to determine which, if any, variables may predict the presence or absence of atypical expressive prosody in the children with HFA; this method is appropriate due to its lack of assumptions regarding normal distributions and equal variances (Tabachnick & Fidell, 2007).

4.1.3.7 Psychometric Considerations

Standardised scores are used for across and between group comparisons where available. The PEPS-C prosody assessment measure is not standardised, therefore comparisons involving this measure are undertaken using raw scores. Age equivalent scores are compared with participants' chronological age, however statistical comparisons of age equivalent scores across measures are not included due to inherent psychometric limitations (Lahey, 1990) such as their tendency to be highly variable across age ranges and assessment tools (Bishop, 2003a).

4.1.3.8 Missing Data

Missing data are coded as such in SPSS for fidelity in analysis. Where comparisons are made between HFA and TD matched pairs, the TD matched participants' data are eliminated on whatever measure(s) is (are) not available for the child with HFA. For analyses in SPSS, the option 'Exclude cases pairwise' is used; this eliminates a participant only for a particular analysis where data are missing (Field, 2005).

4.2 HFA: CURRENT STATUS

The 24 participants (18 male, 6 female) with HFA at T2 range in chronological age from 8.58 to 16 years (*M* 11.91, *SD* 2.25). 18 children (75%) attend school in specialised language units for children with delayed or deviant language or social skills and 6 (25%) attend mainstream schools. In this section, a comparison of means for the entire group across measures will be provided followed by details of the language skills of each participant within the group. Then the children will be grouped by presence and type of language impairment based on their individual results.

4.2.1 Language Assessments

4.2.1.1 Parameters for Impairment

As stated in the methodology section, the criteria chosen to determine if a child's score is indicative of impairment are standard scores falling 1.5 or more standard deviations (< 77.5 where the mean is 100) below the population average (Spaulding et al., 2006) for individual assessments.

4.2.1.2 Assessment Results – HFA-T2 Group Means

Table 4-1 provides the entire HFA-T2 group mean standardised, raw and age-equivalent scores, standard deviations and ranges for all measures except pragmatics, which will be presented separately at the end of this section. As a group, mean standardised scores are highest for non-verbal cognition (RPM), followed by articulation ability for single words (GF), single word expressive vocabulary (EOWPVT-R) and receptive grammar skills (TROG-2); group mean scores for these tasks are within the average range. Group means standard scores that are indicative of impairment are found in the areas of receptive vocabulary (BPVS) and expressive language (CELF-3).

Table 4-1. HFA-T2 Group Means, SD and Range of Scores for Language Assessments; shaded areas indicate standardised scores

HFA T2 Assessment Measure	N	Min	Max	Mean	SD
British Picture Vocabulary Scale (BPVS) Age Equivalent in Years	24	5	16	8.22	2.82
BPVS Raw Score	24	50	135	79.96	22.35
BPVS Standard Score	24	40	116	75.42	20.28
Expressive One-Word Picture Vocabulary Test - Revised (EOWPVT-R) Age Equivalent in Years	24	5	14	7.98	2.41
EOWPVT-R Raw Score	24	56	117	79.33	14.51
EOWPVT- R Standard Score	24	50	121	79.83	18.87
Clinical Evaluation of Language Fundamentals -3 UK (CELF-3) Expressive Subtests Age Equivalent in Years	23	6	9	6.44	0.94
CELF-3 Raw Score	23	15	103	55.22	29.04
CELF-3 Standard Score	23	64	94	71.43	10.66
Goldman-Fristoe Test of Articulation (GF) Raw Score	24	0	42	4.04	9.17
GF Standard Score	24	40	106	92.83	20.1
Test for Reception of Grammar -2 (TROG-2) Age Equivalent in Years	24	3.92	12.25	7.64	2.87
TROG-2 Raw Score	24	3	20	11.88	4.78
TROG-2 Standard Score	24	55	109	79.13	18.25
Raven's Progressive Matrices (RPM) Age Equivalent in Years	24	6	16	10.1	2.23
RPM Raw Score	24	16	40	30.46	6.79
RPM Standard Score	24	70	125	93.46	19.17

4.2.1.3 BPVS Age Equivalent Scores

British Picture Vocabulary Scale – 2nd Edition (BPVS) age equivalent scores range from 4.5 to 13 years (*M* 8.22, *SD* 2.82) with 15 of 24 participants (62.5%) demonstrating an age equivalent score of 7 years or less. Figure 4-1 compares the chronological age of each child with their corresponding BPVS age equivalent score. BPVS age equivalent scores are significantly lower than chronological age ($p < .001$, Wilcoxon Signed Ranks, $z = -3.872$, $r = .79$); however there is an upward trend for the group with much inter-subject variation.

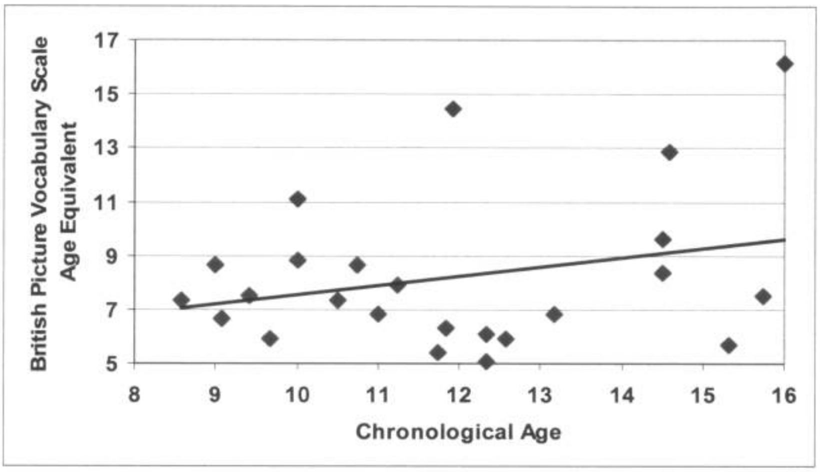


Figure 4-1. Comparison of Chronological Age and British Picture Vocabulary Scale Age-Equivalent Scores for HFA-T2

4.2.1.4 BPVS Standard Scores

BPVS standard scores range from 40 to 116 (*M* 75.42, *SD* 20.28). Table 4-2 shows that 13 of the HFA-T2 children (54.17%) have BPVS standard scores in the impaired range, falling as low as 3 standard deviations below the mean. Thus, a majority of the group have delayed skills in their understanding of single word vocabulary items. Although 11 children have receptive vocabulary skills within the average range, there is a significant difference between group chronological age and BPVS age equivalent scores.

Table 4-2. Distribution of HFA-T2 BPVS Standard Scores. Lightly shaded areas indicate slightly below-average scores; darkly shaded areas indicate scores within impaired range

N	% of Total	Distribution	Score	
1	4.17	+ 1SD	> 115	
8	33.33	Average	85 - 114	n= 11 45.83%
2	8.33	- 1 SD	<85	
4	16.67	-1.5 SD	<77.5	
5	20.83	-2 SD	<70	n=13 54.17%
4	16.67	-3 SD	<55	

4.2.1.5 EOWPVT-R Age Equivalent Scores

The Expressive One-Word Picture Vocabulary Test – Revised (EOWPVT-R) age equivalent scores range from 4.75 to 13.91 years (*M* 7.98, *SD* 2.41) and the majority of children (62.5%) have skills at or below the 7 year level. This matches the finding with the BPVS scores. Figure 4-2 compares the chronological age of each child with their corresponding EOWPVT-R age equivalent score. There is a significant difference between the HFA-T2 chronological age and EOWPVT-R age equivalent score ($p < .001$, Wilcoxon Signed Ranks, $z = -4.029$, $r = .82$) and as with the BPVS, there is an upward trend with great individual variation within the group.

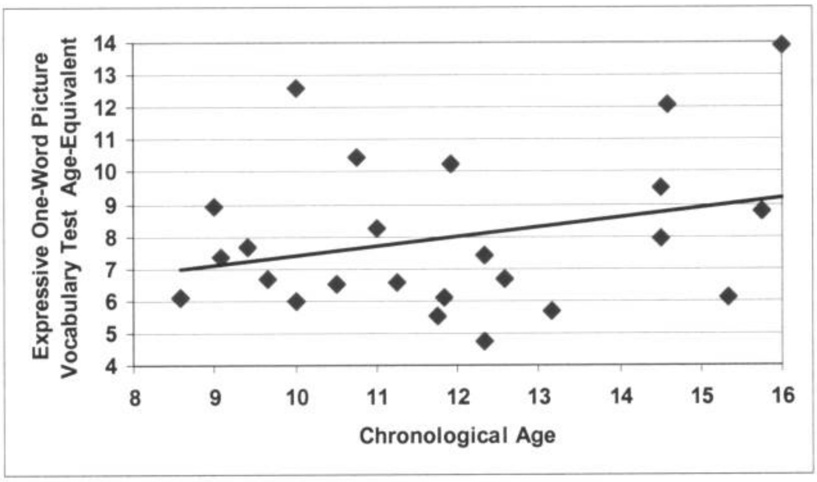


Figure 4-2. Comparison of Chronological Age and Expressive One-Word Picture Vocabulary Test Age-Equivalent Scores for HFA-T2

4.2.1.6 EOWPVT-R Standard Scores

EOWPVT-R standard scores range from 50 to 121 (*M* 79.83, *SD* 18.87). Table 4-3 shows the distribution of standard scores and where they fall compared to the normal distribution. 50% of HFA-T2 children have expressive single word vocabulary skills at or above the average range and the remaining 50% have scores within the impaired range, falling to 2 standard deviations below the mean. Expressive vocabulary skills in this group are slightly better than receptive vocabulary skills, with one less child showing impairment on this measure.

Table 4-3. Distribution of HFA-T2 Expressive One-Word Picture Vocabulary – Revised (EOWPVT-R) Standard Scores. Lightly shaded areas indicate slightly below-average scores; darkly shaded areas indicate scores in impaired range

N	% of Total	Distribution	Score	
1	4.17	+ 1SD	> 115	
7	29.16	Average	85 - 114	n= 12 50%
4	16.67	- 1 SD	<85	
6	25	-1.5 SD	<77.5	n= 12 50%
6	25	-2 SD	<70	

4.2.1.7 CELF-3

Only the expressive subtests of the Clinical Evaluation of Language Fundamentals-3 UK (CELF-3) were administered. One participant was younger than nine years old at the time of testing, therefore he completed the Word Structure, Formulated Sentences and Recalling Sentences subtests, in accordance with the CELF-3 manual (Semel et al., 2000). 22 participants, all over the age of nine years, completed the Formulated Sentences, Recalling Sentences and Sentence Assembly subtests; one participant refused to complete any subtests on the CELF-3. The combined subtests yield a standardised expressive language score with a mean of 100, SD +/- 15; each of the individual subtests yields a standardised score with a mean of 10, SD +/- 3.

4.2.1.8 CELF-3 Age Equivalent Scores

The CELF-3 age equivalent scores range from 5.75 to 8.92 years (*M* 6.44, *SD* .94) with 78.26% of the HFA-T2 group scoring at or below 6 years; this is a full year below the lowest age equivalents on both vocabulary measures. Figure 4-3 compares the chronological age of each child with their corresponding CELF-3 age equivalent score. There is a significant difference between the HFA-T2 chronological age and CELF-3 age equivalent score ($p < .001$, Wilcoxon Signed Ranks, $z = -4.198$, $r = .87$). There is less of an upward trend for the group on the CELF-3 than is seen for receptive and expressive vocabulary; however there is again great variability across individuals.

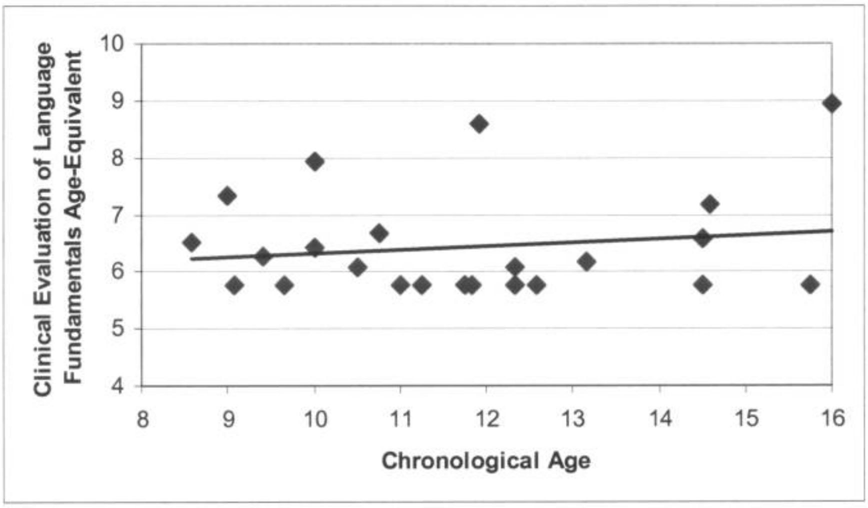


Figure 4-3. Comparison of Chronological Age and Clinical Evaluation of Language Fundamentals Age-Equivalent Scores for HFA-T2

4.2.1.9 CELF-3 Expressive Language Total Standard Scores

CELF-3 standard scores range from 64 to 94 (*M* 71.43, *SD* 10.66). Table 4-4 shows the distribution of standard scores and where they fall compared to the normal distribution. 5 of the 23 HFA-T2 children have scores within the average range (21.74%) and the remaining 18 (78.26%) have scores within the impaired range, falling to 2 standard deviations below the mean. Whilst some BPVS scores fall as low as 3 SD below the mean, the CELF-3 scores do not go lower than 2 SD; however a greater number of children perform at 2 SD or more below the mean on the CELF-3 (n = 14) than on any other measure. Thus expressive language is the most impaired of all language skills assessed in this HFA-T2 group.

Table 4-4. Distribution of HFA-T2 CELF-3 Standard Scores. Lightly shaded areas indicate slightly below-average scores; darkly shaded areas indicate scores in impaired range

N	% of Total	Distribution	Score	
4	17.39	Average	85 - 114	n= 5 21.74%
1	4.34	- 1 SD	<85	
4	17.39	-1.5 SD	<77.5	n= 18 78.26%
14	60.88	-2 SD	<70	

4.2.1.10 CELF-3 Individual Expressive Subtests Standard Scores

Standardised score ranges and SD for each expressive subtest on the CELF-3 are as follows: Formulated Sentences scores range from 3 to 13 (*M* 4.91, *SD* 2.95), Recalling Sentences scores range from 3 to 10 (*M* 5.13, *SD* 2.38) and the Sentence Assembly subtest scores range from 3 to 11 (*M* 4.68, *SD* 2.36). As noted, only one participant completed the Word Structure subtest; he obtained a standard score of 4. Thus, mean scores for each of the subtests are < 5.5 and are therefore within the impaired range (greater than 1.5 SD below the mean). Figure 4-4 presents a graph of mean scores for the expressive subtests of the CELF-3.

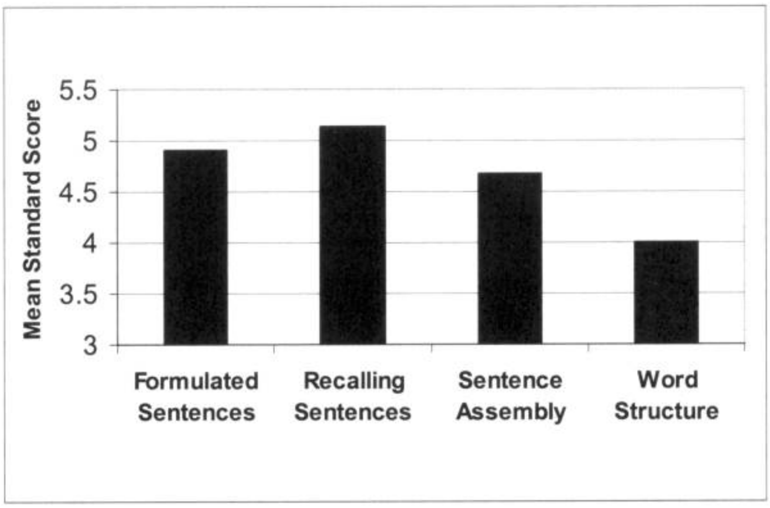


Figure 4-4. Mean Standardised Subtest Scores from the Expressive Section of the Clinical Evaluations of Language Fundamentals-3; a score of 10 (+/- SD 3) represents the average range of scores. All subtest scores are below the population mean.

As reported above, scores for the formulated sentences subtest of the CELF-3 likewise are highly variable. Among the participants, sentence production abilities range from those who were unwilling or unable to do the task, those who produced subordinate clauses rather than complete sentences (e.g., "If they went to the farm" or "While they're baking cookies") to those who produced complete sentences with inconsistent verb tensing (e.g., "Although the boy has broken his arm he was still eager to play"). All of the previous incorrect examples can be described as indicating delayed grammatical skills, supporting previous research that these skills are generally delayed but not deviant (Tager-Flusberg, 1981; Paul & Cohen, 1984; Jarrold et al., 1997; Kjelgaard & Tager-Flusberg, 2001). However there were also examples of non-developmental or deviant grammatical productions, thus replicating the findings by Volden and Lord (1991) that grammatical skills can also be deviant in children with HFA. For example, on the Formulated Sentences subtest of the CELF-3, one child stated "However the lady is showing the five adults in the dentist are very different waters" where the word 'are' appears to be used to indicate 'some' given the content of the picture. Yet, it is not possible to truly know what the child intended, although this sentence is clearly not grammatically, semantically or logically correct. Another child produced an example of deviant grammatical production in the Formulated Sentences subtest. He stated, "Younger the doggies are looking in the trash." This is not an error found in typically developing children (Crystal, Fletcher & Garman, 1989). However, some participants did produce clear sentence structure with appropriate grammar (e.g., "I need to have the right money otherwise I can't get more lunch", "Even if he was quick enough, Jack could have still missed the bus").

4.2.1.11 Semantic Skills

Although semantic abilities were formally assessed through the receptive and expressive vocabulary measures, additional descriptive data is gleaned through a review of responses from the Formulated Sentences subtest of the CELF-3. Specifically, there is evidence of the use of idiopathic meanings and difficulty understanding non-literal uses of words revealed in the conversational speech of some of the participants, similar to findings that have previously been reported (Kanner, 1943/1985; Volden & Lord, 1991; Boucher, 2003). For example, one adolescent described his dislike of a sentence production task by stating, "I'm a bit *summery* for sentences." Another used the term 'slayed' to describe having to do chores for someone. On the structured Formulated Sentences task from the CELF-3, there were also examples of poor semantic use (e.g., "Use some *while* stuff", "You can *until* me whenever you want to"). One participant was told he did a "good job" on a task to which he replied, "I don't need a job."

4.2.1.12 Goldman-Fristoe Test of Articulation

The Goldman-Fristoe Test of Articulation, 2nd Edition (GF) was administered only to the 14 participants who had errors at Time point 1 (58.33% of the HFA-T2 group). As noted in the methodology section, this examiner listened for speech sound production errors throughout the first ninety-minute session; if errors had been noted, the GF would have been administered. However, none of the 10 remaining participants presented with speech sound errors. Therefore, all 24 participants are included in the analysis; those who were not formally assessed at T2 receive a standardised score from the norms table based on their chronological age with a raw score of zero. Overall, standard scores range from 40 to 106 (*M* 92.83, *SD* 20.1); hence single-word articulation ability is the strongest speech and language skill for this HFA-T2 group. 20 children (83.33%) have scores within the average range and 4 children (16.67%) have scores in the impaired range, falling to 3 standard deviations below the mean. Raw scores for the GF reflect the number of sound errors present; the range for these scores is 0 to 42 (*M* 4.04, *SD* 9.17). Table 4-5 presents the distribution of standard scores and Table 4-6 presents the distribution of number of sound errors present in speech.

Table 4-5. Distribution of HFA-T2 Goldman-Fristoe Test of Articulation (GF) Standard Scores. Lightly shaded areas indicate slightly below-average scores; darkly shaded areas indicate scores in impaired range.

N	% of Total	Distribution	Score	
19	79.17	Average	85 - 114	n= 20 83.33%
1	4.17	- 1 SD	<85	
0	0	-1.5 SD	<77.5	n= 4 16.67%
2	8.33	-2 SD	<70	
2	8.33	-3 SD	<55	

Table 4-6. Speech Errors per HFA-T2 Participant (Goldman-Fristoe Raw Scores)

N	% of Total	Total Number of Speech Errors
1	4.17	> 15 errors
2	8.33	11-15 errors
2	8.33	6-10 errors
4	16.67	1-5 errors
15	62.5	0 errors

4.2.1.13 TROG-2 Age Equivalent Scores

The Test for Reception of Grammar, 2nd Edition (TROG-2) age equivalent scores range from 3.92 to 12.25 years (*M* 7.64, *SD* 2.87*)* with 58.33% scoring at or below 6 years with scores falling as low as 3 years, 9 months. Figure 4-5 compares the chronological age of each child with their corresponding TROG-2 age equivalent score. As with the BPVS, EOWPVT-R and CELF-3, there is a significant difference between the HFA-T2 chronological age and TROG-2 age equivalent scores ($p <$ .001, Wilcoxon Signed Ranks, z = -3.857, r =.79). There is a minimal upward trend for the group and as noted with all age equivalent and chronological age equivalent comparisons, there is great heterogeneity of scores across participants.

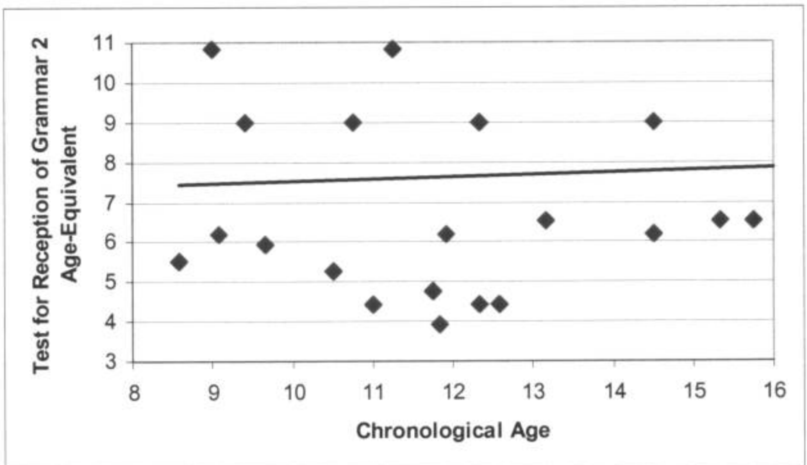


Figure 4-5. Comparison of Chronological Age and Test for Reception of Grammar 2 Age-Equivalent Scores for HFA-T2

4.2.1.14 TROG-2 Standard Scores

TROG-2 standard scores range from 55 to 109 (*M* 79.13, *SD* 18.25). 12 children (50%) have scores within the average range and 12 children (50%) have scores within the impaired range falling to 2 standard deviations below the mean. Table 4-7 illustrates the distribution of standardised scores. As a group, HFA-T2 children show stronger receptive grammar skills than receptive vocabulary or expressive language.

Table 4-7. Distribution of Test for Reception of Grammar -2 (TROG-2) Standard Scores. Lightly shaded areas indicate slightly below-average scores; darkly shaded areas indicate scores in impaired range

N	% of Total	Distribution	Score	
10	41.67	Average	85 - 114	n= 12
2	8.33	- 1 SD	<85	50%
5	20.83	-1.5 SD	<77.5	n= 12
7	29.17	-2 SD	<70	50%

4.2.1.15 Raven's Progressive Matrices

Raven's Progressive Matrices (RPM) was used to assess non-verbal cognitive skills. In accordance with the test manual, children aged below 11 years were assessed via the Coloured Progressive Matrices and those over 11 years were assessed with the Standard Progressive Matrices (Raven et al., 1986). 9 of 24 HFA-T2 children (37.5%) completed the Coloured Matrices and 15 completed the Standard Matrices (62.5%). Raw scores from the Coloured Progressive Matrices were converted to Standard Progressive Matrices raw scores using the conversion table supplied in the test manual (Raven et al., 1986, p. 80) and then converted to percentile ranks and standardised scores.

All of the HFA-T2 children have scores which are broadly within the average range (Bishop, 1997; Kjelgaard & Flusberg, 2001; Botting, 2005), with six children (25%) scoring in the above-average range. However, applying the same impairment criteria with the RPM standard score as with the language measures (scores < 77.5), five children fall within the impaired range. Nevertheless, as a group, non-verbal cognition is an overall area of strength in this group of children with HFA. Table 4-8 details the distribution of scores on the RPM.

Table 4-8. Distribution of Raven's Progressive Matrices (RPM) Standard Scores. Lightly shaded areas indicate slightly below-average scores; darkly shaded areas indicate scores within impaired range

N	% of Total	Distribution	Score	
6	25	+ 1SD	> 115	
6	25	Average	85 - 114	n= 19 79.16%
7	29.17	- 1 SD	<85	
5	20.83	-1.5 SD	<77.5	n= 5 20.83%

4.2.1.16 Language Measures Comparison

Friedman's ANOVA by ranks is undertaken to determine if a significant difference exists among the HFA-T2 group mean standard scores on the BPVS, EOWPVT-R, CELF-3, TROG-2, GF and RPM. Indeed, a significant difference exists ($X^2(2) = 36.53$, $p < .001$) with RPM showing the highest ranking, followed by the GF, EOWPVT, TROG-2, BPVS and CELF-3, respectively. Wilcoxon tests are used to follow up this finding using a Bonferroni correction (.05/11); thus all effects are reported at a .0045 level of significance. A significant difference is noted between RPM and BPVS ($p = .001$, $z = -3.272$, $r = .47$), between GF and CELF-3 ($p = .001$, $z = -3.347$, $r = .48$) and between RPM and CELF-3 ($p < .001$, $z = -4.078$, $r = .59$) confirming that non-verbal cognition and articulation skills are the peak abilities of this HFA-T2 group. Figure 4-6 presents the mean standard scores across the language measures.

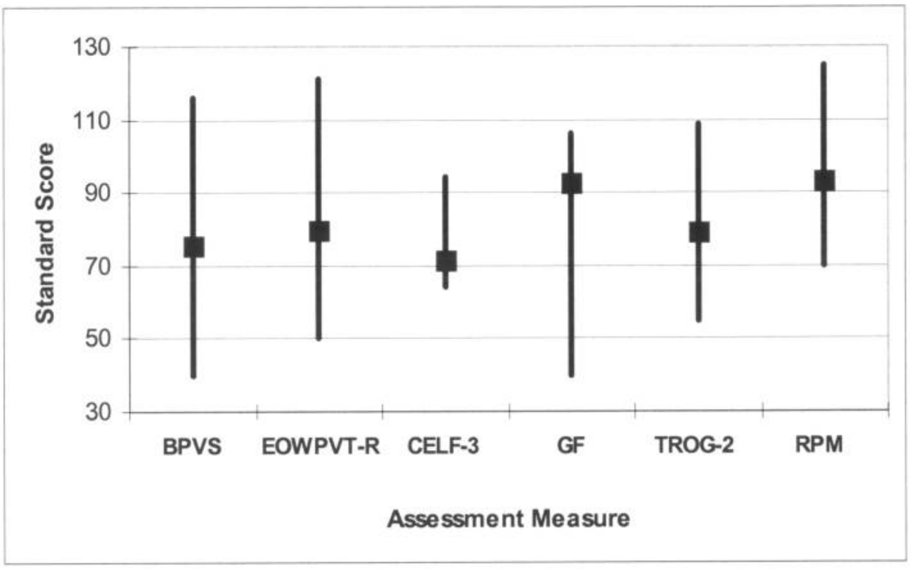


Figure 4-6. Comparison of Standard Scores across Language Measures; square markers indicate group mean and high-lows lines indicate range of scores (BPVS=British Picture Vocabulary Scales; EOWPVT-R=Expressive One-Word Picture Vocabulary Test-Revised; CELF-3=Clinical Evaluations of Language Fundamentals-3 UK; GF=Goldman-Fristoe Test of Articulation; TROG-2=Test for Reception of Grammar -2; RPM=Raven's Progressive Matrices)

4.2.1.17 Assessment Results by Individual Participants

All 24 participants completed the BPVS, EOWPVT-R, TROG-2, GF and RPM; a total of 23 participants (95.83%) completed the CELF-3 (one participant refused to complete this measure). Table 4-9 shows the detail of standard scores below 77.5 for each measure. The highest percentage of children (78.26%) scoring within the range of impairment occurs on the CELF-3. 50% of children are within the impaired range on both the TROG-2 and the EOWPVT-R, whilst slightly less show impairment on the BPVS (45.83%). Single word articulation skills (GF) are least impaired, with only 16.67% falling in the impaired range. Thus, results for children with HFA at T2 indicate that they have the most challenge with expressive language skills and demonstrate the greatest success on non-verbal cognitive and single word articulation skills. Appendix XI (pp. 263-286) presents individual scores for each HFA-T2 participant.

Table 4-9. Standard Scores Indicating Impairment across Each Measure by Each Participant; shaded areas indicate score above 77.5 (thus within normal limits). X indicates assessment not completed. (BPVS=British Picture Vocabulary Scales; EOWPVT-R=Expressive One-Word Picture Vocabulary Test-Revised; CELF-3=Clinical Evaluations of Language Fundamentals-3 UK; GF=Goldman-Fristoe Test of Articulation; TROG-2=Test for Reception of Grammar -2; RPM=Raven's Progressive Matrices; WNL=within normal limits)

			HFA - T2			
ID	BPVS	EOWPVT-R	CELF-3	TROG-2	GF	RPM
01 HFA						
02 HFA	77	74	64	60		75
04 HFA	59	62	64			
05 HFA	64	67	65	55		
06 HFA	55	63	65	55		
07 HFA	55	74	64		55	
08 HFA	48	56	64	55		75
09 HFA			72			75
10 HFA					62	
12 HFA	70		65	55		
14 HFA			76			
15 HFA				74		
16 HFA	50	73	65	71		
17 HFA	54	69	64	55	48	
18 HFA	62	72	64	67		
19 HFA		73	70		40	75
20 HFA	40	60	X	71		75
21 HFA		72	65			
22 HFA			65			
23 HFA	71		65	76		
24 HFA	68		64			
27 HFA						
30 HFA				72		
31 HFA			75			
Impaired	11 (45.83%)	12 (50%)	18 (78.26%)	12 (50%)	4 (16.67%)	5 (20.83%)
WNL	13 (54.17%)	12 (50%)	5 (21.74%)	12 (50%)	20 (83.33%)	19 (79.17%)
Total N	24	24	23	24	24	24

4.2.1.18 CCC-2 Pragmatic Scores

The Children's Communication Checklist, 2nd edition (CCC-2), a questionnaire that aims to identify and describe pragmatic impairments, was completed by the mothers of 22 of 24 (91.67%) children from the HFA-T2 group. The General Communication Composite score (GCC) is comprised of combined scores from 10 individual scales. HFA-T2 group GCC scores range from 4 to 60 (*M* 24.09, *SD* 15.13). These scores are consistent with Bishop's (2003b) assertion that almost all children with ASDs score below 55. The Social Interaction Deviance Composite

(SIDC) was designed to support research on differential diagnoses for children for whom the GCC score is below 55; however the CCC-2 was not designed to be a diagnostic tool (Bishop, 2003). HFA-T2 SIDC scores range from -18 to 5 (*M* -5.59, *SD* 7.53). A SIDC of less than 8 is consistent with the profiles from Bishop's (2003b) data of children with ASD; all of the HFA-T2 participants have scores within this range. Figure 4-7 shows the GCC plotted against the SIDC.

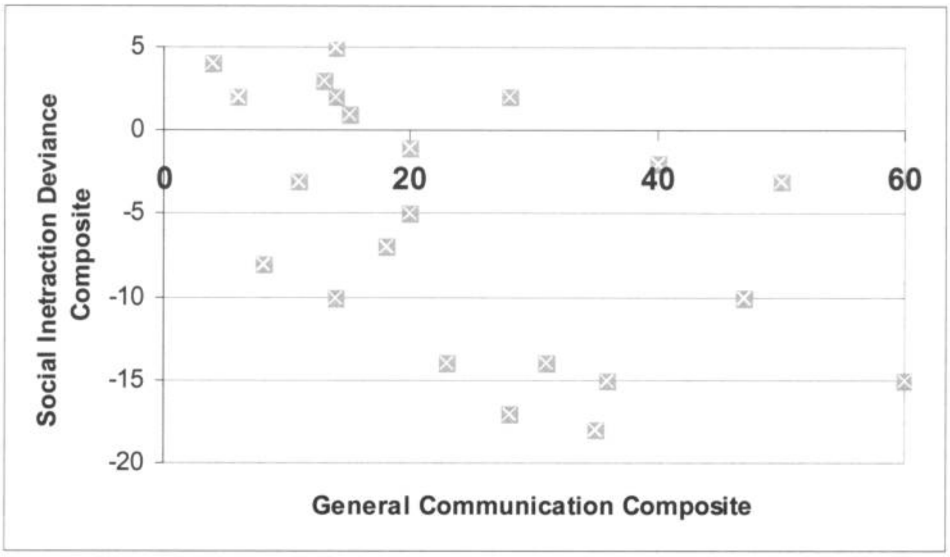


Figure 4-7. General Communication Composite Scores Plotted Against the Social Interaction Deviance Composite. Both scores are from the Children's Communication Checklist-2 (CCC-2).

4.2.1.19 CCC-2 Scale Scores

The mean group scores for the individual scales on the CCC-2 are presented in Figure 4-8. Scores at or above a scaled score of 6 are within normal limits; none of the HFA-T2 group means reach this level. Although all skills are below the normal range, speech and syntax are relative strengths whereas use of context and social relations are the areas on which the group shows greatest deficits, consistent with profiles of individuals with clinically significant communication difficulties (Bishop, 2003b) such as HFA.

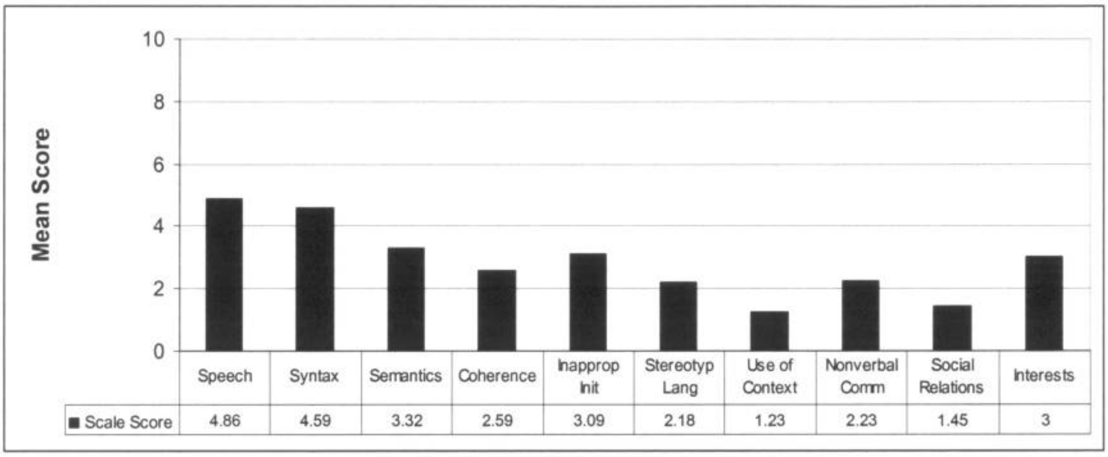


Figure 4-8. HFA-T2 Group Mean Scores for Individual Scales from the Children's Communication Checklist (CCC-2)

4.2.1.20 Correlations between Language Measures and Non-Verbal Cognition

Details of correlations between language measures, chronological age and non-verbal cognitive skills are detailed in Table 4-10. There are strong positive inter-correlations noted between all the language measures with the exception of the Goldman-Fristoe Test of Articulation, thus articulation skills stand apart from vocabulary, expressive language and receptive grammar skills. Chronological age negatively correlates to non-verbal cognitive skills (RPM), pragmatic skills (the General Communication Composite score from the Children's Communication Checklist-2) and to receptive vocabulary (BPVS), thus within this HFA-T2 group the older the children, the lower their scores are on these measures. The Social Interaction Deviance Composite score from the Children's Communication Checklist-2 shows strong negative correlations with receptive and expressive vocabulary and weaker negative correlations with the expressive language and grammar measures; the children with higher language scores are evidencing more unusual pragmatic skills than the children with inferior language skills. However this could possibly be due to the fact that children with better language skills may seem more impaired simply due to the fact that they provide more conversation.

Table 4-10. Correlation Matrix Representing Standard Scores on Language Measures, Chronological Age and Non-Verbal Cognitive Skills; darkly shaded areas indicate significance at .01 level, lightly shaded areas indicate significance at .05 level (Spearman's rho, 2-tailed), blank cell indicates no significance. (CA=Chronological Age; BPVS=British Picture Vocabulary Scales; EOWPVT-R=Expressive One-Word Picture Vocabulary Test-Revised; CELF-3=Clinical Evaluations of Language Fundamentals-3 UK; GF=Goldman-Fristoe Test of Articulation; TROG-2=Test for Reception of Grammar -2; RPM=Raven's Progressive Matrices; GCC=General Communication Composite; SIDC=Social Interaction Deviance Composite)

		CA	BPVS	EOWPVT-R	CELF-3	TROG-2	GF	RPM	GCC	SIDC
CA	Corr Co		-.461					-.456	-.490	
	Sig.		.023					.025	.021	
	N		24					24	22	
BPVS	Corr Co	-.461		.828	.834	.672				-.650
	Sig.	.023		<.001	<.001	<.001				<.001
	N	24		24	23	24				22
EOWPVT-R	Corr Co		.828		.758	.648		.461		-.592
	Sig.		<.001		<.001	<.001		.025		.004
	N		24		23	24		24		22
CELF-3	Corr Co		.834	.758		.553				-.510
	Sig.		<.001	<.001		.006				.018
	N		23	23		23				22
TROG-2	Corr Co		.672	.648	.553					-.508
	Sig.		<.001	<.001	.006					.016
	N		24	24	23					22
GF	Corr Co									
	N									
RPM	Corr Co	-.456		.461					.681	
	Sig.	.025		.025					<.001	
	N	24		24					22	
GCC	Corr Co	-.490						.681		-.600
	Sig.	.021						<.001		.003
	N	22						22		22
SIDC	Corr Co		-.650	-.592	-.510	-.508			-.600	
	Sig.		<.001	.004	.018	.016			.003	
	N		22	22	22	22			22	

4.2.1.21 Language Impairment Profiles for HFA-T2 Participants

The BPVS (vocabulary) and the TROG-2 (grammar) are receptive language measures; EOWPVT-R (vocabulary) and CELF-3 (language production) are the expressive language measures. Examination of individual standard scores across these language measures reveals four separate profiles. A standard score of less than 77.5 (more than 1.5 standard deviations below the population mean) on one or more receptive measure, but with all expressive scores within normal limits is labelled receptive-impairment-only; impairment on one or more expressive measures with both receptive scores within normal limits is labelled expressive-impairment-only; impairment on one or more receptive measure *and* one or more expressive measure is labelled expressive-and-receptive-impairment; scores on all language measures that are within normal limits is labelled WNL. Recalling that by definition, all children with HFA have a history of preschool language delays, it is not surprising that the majority continue to evidence language impairment. Combined receptive-and-expressive-impairment (n = 13) is most common in the HFA-T2 group, followed by expressive-impairment-only (n = 6), with WNL (n = 3) and receptive-impairment-only (n = 2) the least common profiles for this group. Figure 4-9 illustrates the breakdown of the individual profiles within the HFA-T2 group.

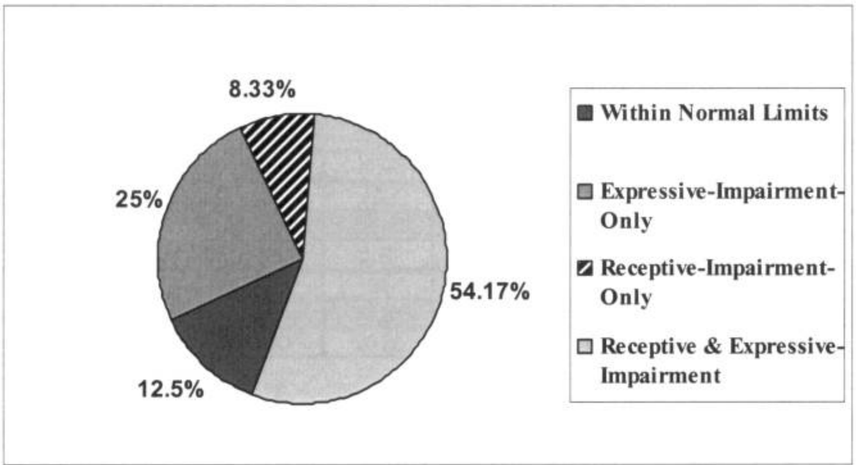


Figure 4-9. Individual Profiles of Impairment within HFA-T2 Group

4.2.1.22 Impairment Profile Groups – Language Scores

Table 4-11 details the means between the four profile groups and compares them to the means of the entire group and to performance on the measures of language, articulation (GF) and non-verbal cognitive skills (RPM). Some of the results seem counter-intuitive, for example the receptive-impairment-only group has a mean BPVS (receptive language measure) of 103 which is greater than the mean score for the WNL group. This is due to one participant scoring very highly on the BPVS but below 77.5 on the TROG-2 (receptive grammar). Additionally, the scores on the expressive vocabulary measure (EOWPVT-R) are almost identical for the receptive-impairment-only group and the expressive-impairment-only group. However, the extremely small group numbers limit the conclusions that can be made from this data.

Table 4-11. Mean Standard Scores and Standard Deviations of Participants by Impairment Profile Groups (including comparison to performance on non-verbal cognitive assessment); mean scores are shaded. (BPVS=British Picture Vocabulary Scales; EOWPVT-R=Expressive One-Word Picture Vocabulary Test-Revised; CELF-3=Clinical Evaluations of Language Fundamentals-3 UK; GF=Goldman-Fristoe Test of Articulation; TROG-2=Test for Reception of Grammar -2; RPM=Raven's Progressive Matrices)

GROUP		BPVS	EOWPVT-R	CELF-3	TROG-2	GF	RPM
Expressive-Impairment-Only	N	6	6	6	6	6	6
	Mean	**85.00**	**85.00**	**70.50**	**93.17**	**92.50**	**93.00**
	SD	5.02	10.51	4.76	8.98	25.87	16.96
Receptive-Impairment-Only	N	2	2	2	2	2	2
	Mean	**103**	**86**	**86**	**73**	**105.5**	**104**
	SD	18.38	8.49	11.31	1.41	0.71	21.21
Receptive & Expressive-Impairment	N	13	13	12	13	13	13
	Mean	**60.23**	**70.15**	**64.42**	**67.31**	**93.38**	**88.62**
	SD	11.05	8.27	0.51	12.75	19.11	17.45
Within Normal Limits	N	3	3	3	3	3	3
	Mean	**103.67**	**103.33**	**91.67**	**106.33**	**86.67**	**110**
	SD	5.77	12.10	2.08	2.52	21.55	25.98
ALL HFA	N	24	24	23	24	24	24
	Mean	**75.42**	**79.33**	**71.43**	**79.13**	**92.83**	**93.67**
	SD	20.28	14.51	10.66	18.25	20.10	18.93

Kruskal-Wallis tests reveal significant differences between groups on the BPVS (H (3) 18.663, $p < .001$), the CELF-3 (H (3) 17.452, $p < .001$), the TROG-2 (H (3) 15.709, $p < .001$) and the EOWPVT-R (H (3) 13.441, $p = .004$) but no significant differences between groups on the RPM (H (3) 3.747, $p = .313$) or GF (H (3) 3.675, $p = .320$). To follow up this these findings, Kolmogorov-Smirnov tests are undertaken with the Bonferroni correction (significance level of .005) on the BPVS, CELF-3, TROG-2, and EOWPVT-R. Table 4-12 presents details of findings that are significant or approach significance along with the Z, p and r values. As expected, the WNL group significantly outperforms the receptive-and-expressive-impairment group on all measures. However no significant differences are noted between the WNL and expressive-impairment-only or receptive-impairment-only groups; most surprising is the absence of a significant difference on either the receptive grammar or receptive vocabulary tests. The expressive-impairment-only group scores higher than the receptive-and-expressive-impairment group on all measures, reaching significance on the BPVS and the TROG-2, and approaching significance on the CELF-3. Finally, the receptive-impairment-only group approaches significance in outperforming the expressive-and-receptive-impairment group on the BPVS and the CELF-3 but not on the EOWPVT-R or the TROG-2.

Table 4-12. Comparisons across Presence and Type of Impairment Groups. Each of the six blocks represents a different group comparison. Significance at the .005 level is indicated by dark shading in the blocks, light shading indicates results that approach significance. NS means no significant differences. (BPVS=British Picture Vocabulary Scales; EOWPVT-R=Expressive One-Word Picture Vocabulary Test-Revised; CELF-3=Clinical Evaluations of Language Fundamentals-3 UK; GF=Goldman-Fristoe Test of Articulation; TROG-2=Test for Reception of Grammar -2; RPM=Raven's Progressive Matrices; WNL=Within normal limits; Rec-&-Exp Imp=Receptive-and-expressive-impairment group; Rec-Imp=receptive-impairment-only group; Exp-Imp=expressive-impairment-only group)

WNL outperforms Rec-&-Exp	
BPVS	Z=1.561, p = .004, r = .39
CELF-3	Z = 1.549, p = .002, r = .39
TROG-2	Z=1.561, p = .002, r = .39
EOWPVT-R	Z=1.561, p = .004, r = .39

WNL outperforms Rec-Imp	
BPVS	ns
CELF-3	ns
TROG-2	ns
EOWPVT-R	ns

Rec-Imp outperforms Rec-&-Exp Imp	
BPVS	Z=1.317, p = .019, r = .34
CELF-3	Z = 1.309, p = .011, r = .34
TROG-2	ns
EOWPVT-R	ns

Exp-Imp outperforms Rec-Imp	
BPVS	ns
CELF-3	ns
TROG-2	ns
EOWPVT-R	ns

WNL outperforms Exp-Imp	
BPVS	ns
CELF-3	ns
TROG-2	ns
EOWPVT-R	ns

Exp-Imp outperforms Rec-&-Exp Imp	
BPVS	Z=2.026, p < .001, r = .46
CELF-3	Z = 1.333, p = .018, r = .31
TROG-2	Z=1.714, p = .001, r = .39
EOWPVT-R	ns

4.2.1.23 CCC-2 Scores by Language Impairment Profiles

Table 4-13 presents results of the each of the subtests from the Children's Communication Checklist-2 (CCC-2) and total score by presence and/or type of language impairment. The expressive-impairment-only group generally performs worse than the receptive-and-expressive-impairment group on all measures except speech, syntax, stereotyped language and the General Communication Composite (GCC). However, Kruskal-Wallis tests results reveal no significant differences between the four groups on any scores from the CCC-2.

Although the WNL group generally outperforms all the impaired-language groups, as well as the HFA group as a whole, the WNL group have the lowest SIDC score. This indicates the WNL group have a greater impairment with social interaction skills than those with receptive-and-expressive-impairments. As noted earlier, this may be a result of the WNL group being more talkative than the receptive-and-expressive-impairment group, thus the WNL group may provide more opportunity to be judged as having pragmatic impairment.

Table 4-13. Individual Scale and Composite Scores from the Children's Communication Checklist-2 (CCC-2) Scores by Impairment Profiles; shaded areas indicate mean scores. (WNL=Within normal limits; Exp-Imp=Expressive-impairment-only group; Rec-Imp=Receptive-impairment-only group; Rec-&-Exp-Imp=Receptive-and-expressive-impairment group)

		WNL	Exp-Imp	Rec-Imp	Rec-&-Exp-	All HFA
Speech	N	3	6	2	11	22
	Mean	7.67	4.33	8.5	3.73	4.86
	SD	4.04	4.46	3.54	3.13	3.83
Syntax	N	3	6	7	11	22
	Mean	7.67	5.17	5	3.27	4.59
	SD	4.04	3.13	2.89	3.95	3.79
Semantics	N	3	6	2	11	22
	Mean	4	3.17	3	3.27	3.32
	SD	3.61	1.94	0	2.87	2.48
Coherence	N	3	6	2	11	22
	Mean	2.67	2.67	3.5	2.36	2.59
	SD	3.06	2.34	3.54	1.36	1.94
Inappropriate Initiation	N	3	6	2	11	22
	Mean	2.67	3.33	3	3.09	3.09
	SD	2.52	1.63	0	1.45	1.51
Stereotyped Language	N	3	6	2	11	22
	Mean	2.67	3.17	1.5	1.64	2.18
	SD	3.06	2.4	0.71	1.57	1.99
Use of Context	N	3	6	2	11	22
	Mean	3.33	1	0	1	1.23
	SD	3.51	1.27	0	2.05	2.09
Nonverbal Communication	N	3	6	2	11	22
	Mean	2.33	1.5	1.5	2.73	2.23
	SD	2.52	1.23	0.71	2.65	2.16
Social Relations	N	3	6	2	11	22
	Mean	1.67	0.67	1.5	1.82	1.45
	SD	2.89	1.21	2.12	1.72	1.74
Interests	N	3	6	2	11	22
	Mean	3	3.33	2	3	3
	SD	3.61	2.34	0	2.1	2.18
General Communication Composite (GCC)	N	3	6	2	11	22
	Mean	33	24.33	26.5	21.09	24.09
	SD	26.06	11.29	12.02	15.23	15.13
Social Interaction Deviance Composite (SIDC)	N	3	6	2	11	22
	Mean	-12.33	-6.5	-12.5	-2	-5.59
	SD	3.79	7.5	7.78	6.65	7.53

4.2.2 Prosody Assessment

4.2.2.1 Rationale for Eliminating a Portion of Data

Three of the HFA participants at T2 were part of a small therapeutic feasibility study conducted in 2004 by the Prosody in High-Functioning Autism project team that collected the T1 data. The details and results have not been analysed or published but were provided to the author of the current study after the T2 data collection was complete.

Information about the therapeutic programme was provided by the researcher who conducted it (J. McCann, personal communication, July 27, 2006). The children (all male) who received therapy were 11;09, 12;04 and 12;07 at the T2 testing and the therapy was provided approximately 12 months after T1 testing and 12-16 months before the T2 testing occurred. One of the children (06HFA) had two 30-minute therapy sessions and two children (07HFA and 17HFA) had eight 30-minute sessions. The main targets of the therapy sessions were 1) auditory discrimination of intonation and prosody, as presented with recorded laryngograph recordings on a computer as well as discrimination of real words in speech; 2) perceiving differences in volume of speech; 3) perceiving affective prosody and identifying it as happy/sad and surprised/not surprised; 3) perceiving differences in phrase chunking by identifying two person (e.g., Joanne and Sarah) vs. three person combinations (e.g., Jo, Anne and Sarah).

While the outcome of therapeutic intervention is not a part of the current study, it is deemed important to examine how the scores of these children compared to the rest of the HFA-T2 group. Therefore a review of possible confounds that might effect the results of the current study is presented. The mean gain for the total PEPS-C score is 46.8 (*SD* 18.3) for the children who received therapy (n = 3) and 23.2 (*SD* 17.8) for the children who did not receive therapy (n = 18), although Kolmogorov-Smirnov tests reveal the intervention group did not reach significance in outperforming the rest of the HFA-T2 group on the gain on the PEPS-C over time. Additionally, no significant differences are noted on gains on language measures. Nonetheless, the higher scores appear to be specific to performance on the PEPS-C, rather than reflective of large overall developmental gains of the three children. Individual data for the three children (06 HFA, 07 HFA, 17 HFA) who received intervention can be found in Appendix XI, pp. 267, 268 and 276, respectively.

It is not known whether or not the other participants received prosody therapy from their own speech and language therapist. However, it is known that the other children could not have received intervention via materials modelled on the PEPS-C program as did the three children in the pilot study; the PEPS-C is currently only available as a research tool and is not yet available to clinical speech and language therapists. Therefore, because the therapy was specifically directed towards several of the same discreet receptive prosodic skills that are assessed in the PEPS-C (affect, chunking and auditory discrimination of single word and short phrase laryngographs) and it was only provided to three of the 24 participants, it is decided that these three children will be removed from any subsequent analyses involving performance on the PEPS-C at T2. However, they continue to be included in all other analyses (i.e., language and ToM).

4.2.2.2 PEPS-C Total and Subtest Scores – Group

Raw scores for Profiling Elements of Prosodic Systems in Children (PEPS-C) (Peppé et al., 2003) are presented along with the total percentage correct for the entire assessment. In addition to the three participants removed from the PEPS-C data set at T2 because of their involvement in an intervention program, one participant refused to complete any output subtests and one participant did not complete one output subtest. Thus group data are comprised of the individual results of 19-21 children, depending on the score reported. Table 4-14 details the means, standard deviations, range and number of participants for the PEPS-C scores and Figure 4-10 compares the mean raw scores for each of the individual subtests. As was discussed in the methodology chapter (Section 3.1.5.6, p. 84) both inter- and intra-rater agreement for the output tasks were high (*M* 93.98% and 96.5%, respectively). For each subtest in the PEPS-C, scores ≥12 indicate that competency on the specific task has been achieved (Peppé & McCann, 2003). As a group, competency level was met or surpassed on all subtests except Turn-End output, Chunking input and output, Focus input, and Intonation output. For each subtest, the highest raw score possible is 16. As can be seen in Table 4-14 under the maximum score column, maximum scores of 16 are obtained on all but one subtest, indicating ceiling effects. Thus, at least some of the HFA T2 children may have found the majority of tasks too easy. There are no normative data available for the PEPS-C; however Table 4-42 (p. 186) presents a comparison of the HFA-T2 PEPS-C results to those from the typically developing group.

Table 4-14. HFA-T2 Profiling Elements of Prosodic Systems-Children (PEPS-C) Mean Raw Scores, Standard Deviations, Score Ranges and Number of Participants

PEPS-C Scores HFA-T2					
	N	Min	Max	Mean	SD
Turn-End Input	21	3	16	12.00	4.02
Turn-End Output	20	7	16	11.45	3.53
Affect Input	21	6	16	13.24	2.95
Affect Output	19	6	16	13.11	2.60
Chunking Input	21	8	16	11.90	2.47
Chunking Output	20	8	16	11.80	2.33
Focus Input	21	7	16	9.76	3.02
Focus Output	20	6	16	12.25	2.67
Intonation Input	21	5	16	13.81	2.99
Intonation Output	20	4.5	15.5	11.50	4.01
Prosody Input	21	5	16	12.81	3.63
Prosody Output	20	6	16	12.88	2.87
Input Subtests Total	21	49	96	73.52	12.80
Output Subtests Total	19	43.5	94.5	73.16	12.61
Percent Correct	19	53.91	99.22	76.44	12.27
PEPS-C Total	19	103.5	190.5	146.84	23.65

4.2.2.3 PEPS-C Comparison of Receptive and Expressive Abilities

As is shown in Table 4-14, for the majority of the subtests, mean group receptive (input) abilities are higher than expressive (output) abilities. Only the Focus and Prosody mean scores are higher for expressive than receptive ability. However, the

Wilcoxon signed ranks test reveals significant differences only occur on two subtests: 1) Intonation, where the receptive scores are significantly higher than the expressive scores ($p = .003$, $Z = -2.809$, $r = .62$) and 2) Focus, where the expressive scores are significantly higher than the receptive scores ($p = .003$, $Z = -2.800$, $r = .62$). Although the score is higher for the combined receptive subtests than for the combined expressive subtests, there is no significant difference between them ($p = .961$, Z = -.060).

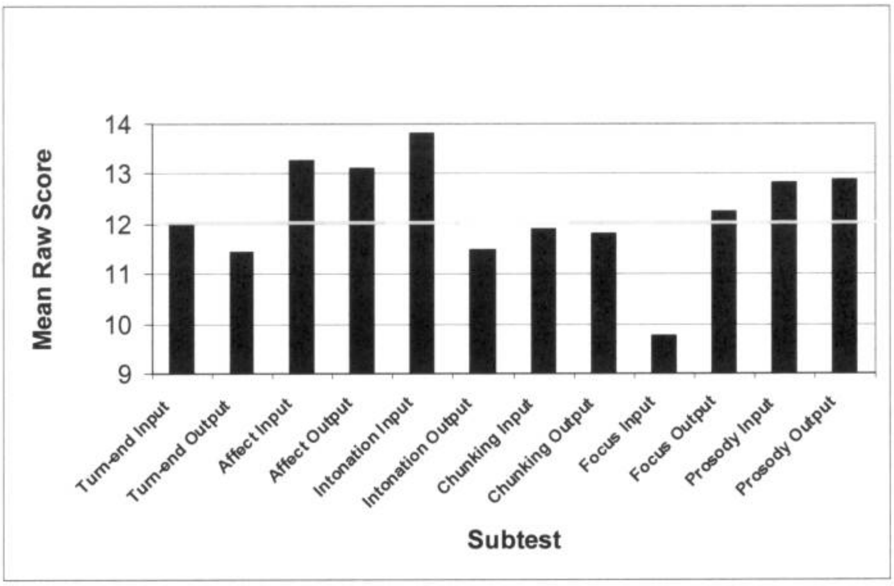


Figure 4-10. Profiling Elements of Prosodic Systems –Children (PEPS-C) Mean Raw Subtest Scores; scores within and above the yellow bar ($\geq$12) indicate competency level (75% correct) has been reached. The highest possible raw score for each subtest is 16.

4.2.2.4 Prosody and Language

Correlation (Spearman's rho) analyses reveal several significant relationships between PEPS-C total, input subtests and output subtests scores with both vocabulary measures (BPVS and EOWPVT-R) and expressive language (CELF-3). A single subtest (Turn-End input) shows significance with non-verbal cognition (RPM). Both the Affect and Focus output subtests show a significant correlation with receptive grammar (TROG-2). None of the PEPS-C scores show a significant correlation with chronological age, single-word articulation skills (GF) or pragmatic skills. Table 4-15 provides details of these findings.

Table 4-15. HFA-T2 Language and Prosody Correlations. Lightly shaded areas indicate significance at α level (<.05); darkly shaded areas indicate significance at <.01 using Spearman's Rho, 2-tailed. (BPVS=British Picture Vocabulary Scales; EOWPVT-R=Expressive One-Word Picture Vocabulary Test-Revised; CELF=Clinical Evaluations of Language Fundamentals-3 UK; GF=Goldman-Fristoe Test of Articulation; TROG-2=Test for Reception of Grammar -2; RPM=Raven's Progressive Matrices; CA=Chronological Age; CCC-2=Children's Communication Checklist -2; GCC=General Communication Composite; SIDC=Social Interaction Deviance Composite)

		BPVS	CELF	RPM	TROG-2	EOWPVT-R	GF	C.A.	CCC-2 GCC	CCC-2 SIDC
Turn-End Input	r_s	.483		.517		.571				
	p	.026		.016		.007				
	n	21		21		21				
Turn-End Output	r_s	.470	.619			.576				
	p	.036	.004			.008				
	n	20	20			20				
Affect Input	r_s	.613	.513			.553				
	p	.003	.021			.009				
	n	21	21			21				
Affect Output	r_s	.725	.748		.560	.657				
	p	<.001	<.001		.013	.002				
	n	19	19		19	19				
Intonation Input	r_s		.604							
	p		.005							
	n		20							
Intonation Output	r_s		.576							
	p		.008							
	n		20							
Chunking Input	r_s									
	p									
	n									
Chunking Output	r_s	.477	.471							
	p	.033	.036							
	n	20	20							
Focus Input	r_s									
	p									
	n									
Focus Output	r_s	.511	.522		.470					
	p	.021	.018		.037					
	n	20	20		20					
Prosody Input	r_s	.473	.543			.523				
	p	.030	.013			.015				
	n	21	20			21				
Prosody Output	r_s		.448							
	p		.048							
	n		20							
PEPS-C Total	r_s	.741	.787			.731				
	p	<.001	<.001			<.001				
	n	19	19			19				
Input Subtests Total	r_s	.587	.687			.572				
	p	.005	.001			.007				
	n	21	20			21				
Output Subtests Total	r_s	.639	.844			.523				
	p	.003	<.001			.021				
	n	19	19			19				

4.2.2.5 Subjective Judgments of Expressive Prosody

As described in Chapter 3, section 3.1.5.7 (p. 84), this examiner made subjective judgments of the expressive prosody of 20 children in the HFA-T2 group during testing. No judgment could be made about one participant, due to the paucity of verbal responses from him. Additionally, three individuals were eliminated from PEPS-C T2 data analyses due to participation in a pilot prosody intervention. This examiner was blind to the subjective ratings made by the T1 research team until all T2 testing was completed. There was 100% inter-rater agreement on the subjective judgments across Time points.

Seventy percent (14 of 20 children) are judged to have atypical expressive prosody (AEP) and thirty percent (6 of 20 children) do not have unusual expressive prosody (No-AEP). Comparing the frequency across gender, 4 out of 6 girls (67%) and 10 of 14 boys (71%) have AEP. Additionally, the AEP can be further described as having either excessive variability (e.g., exaggerated, sing-song), hereafter referred to as exaggerated-AEP, or having highly limited variability (e.g., robotic, flat, monotonous), hereafter referred to as monotonous-AEP. Seven children have exaggerated-AEP (50%) and seven have monotonous-AEP (50%). The majority of the girls (75%) have monotonous-AEP, whilst the majority of the boys (60%) have exaggerated-AEP.

4.2.2.6 AEP and Presence and Type of Language Impairment

The percentage of AEP vs. No-AEP for each group created according to presence and type of language impairment is presented in Figure 4-11. The largest impairment group (receptive-and-expressive-impairment) has the highest percentage of children with AEP (100%) whilst the WNL group has the lowest (33.3%). Table 4-16 shows the percentage of those participants with monotonous-AEP vs. exaggerated-AEP by presence and type of language impairment groups and shows that children with combined receptive-and-expressive-impairment are much more likely to have AEP than those with less severe language impairments.

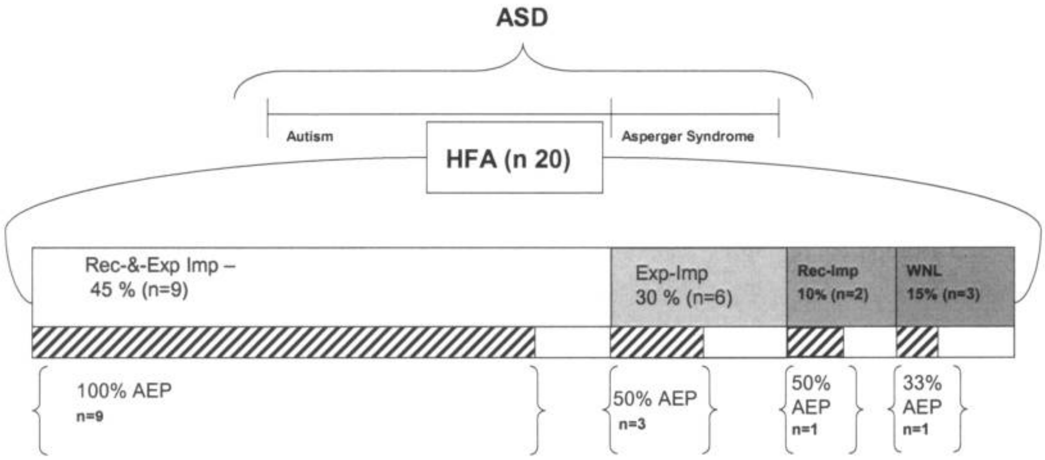


Figure 4-11 Representation of HFA Within the Autism Spectrum as a Distinctive Subgroup of Autistic Disorder (and Separate from Those with Asperger Syndrome); highlighting the presence or absence of Atypical Expressive Prosody (AEP) within groups by presence and type of language impairment. (Rec-&-Exp Imp=Receptive-and-expressive-impairment group; Exp-Imp= Expressive-impairment-only group; Rec-Imp=Receptive-impairment-only group; WNL=Within normal limits). *Note this figure excludes four participants; three participants were part of a prosodic intervention pilot study and one participant did not provide enough expressive output to receive a judgment of expressive prosodic ability*

Table 4-16. Type of Atypical Expressive Prosody (AEP) by Presence and Type of Language Impairment

Language Profile Group	Type of AEP	%
Receptive- and-Expressive-Impairment	5 monotonous	55.6
	4 exaggerated	44.4
	Total	*100%*
Expressive-Impairment-Only	1 monotonous	33.3
	2 exaggerated	66.7
	Total	*100%*
Receptive-Impairment-Only	0 monotonous	0
	1 exaggerated	100
	Total	*100%*
Within Normal Limits	1 monotonous	100
	0 exaggerated	0
	Total	*100%*

4.2.2.7 Presence and Type of Language Impairment and PEPS-C Performance

The Kruskal-Wallis (exact) test reveals significant differences between the WNL and language impairment groups only on the PEPS-C output score (H (3) 7.404, p = .039) with the receptive-impairment-group showing the highest ranking and the receptive-and-expressive impairment group the lowest. Kolmogorov-Smirnov tests are used to follow up this finding between these two groups. Indeed, the receptive-impairment-only group significantly outperforms the receptive-and-expressive-impairment group on the PEPS-C output score (p = .036, Z = 1.279, r = .39). Table 4-17 shows the mean PEPS-C total, input and output scores by presence and type of language impairment groups.

Table 4-17. Profiling Elements of Prosodic Systems-Children (PEPS-C) Scores by Impairment Profiles; shaded areas indicate mean raw scores

GROUP		PEPS-C Total	PEPS-C Input	PEPS-C Output
Expressive-Impairment-Only	N	5	6	5
	Mean	**145.20**	**69.50**	**74.00**
	SD	22.19	10.86	11.75
Receptive-Impairment-Only	N	2	2	2
	Mean	**171.25**	**81.5**	**89.75**
	SD	27.22	20.51	6.72
Receptive-and-Expressive Impairment	N	9	10	9
	Mean	**135.94**	**70.7**	**66.61**
	SD	22.05	12.39	11.84
Within Normal Limits	N	3	3	3
	Mean	**166**	**85.67**	**80.33**
	SD	6.61	8.33	4.80
ALL HFA	N	19	21	19
	Mean	**146.84**	**73.52**	**73.16**
	SD	23.65	12.80	12.61

4.2.2.8 Comparison of HFA Children with and without AEP - Overview

To determine if any differences between the HFA-T2 children with exaggerated-AEP, monotonous-AEP, and No-AEP exist on the performance of language and PEPS-C tasks, a comparison across three groups is performed, followed by a comparison of AEP (any type) vs. No-AEP. However, results of these comparisons must be interpreted cautiously due to the small and unequal group sizes.

4.2.2.9 Comparison of HFA Children with and without AEP - Language

The Kruskal-Wallis (exact) test reveals significant differences between the No-AEP, monotonous-AEP and exaggerated-AEP groups only on the BPVS standard score (H (2) 9.424, p = .004). Kolmogorov-Smirnov tests are used to follow up this finding using a .016 level of significance after the Bonferroni correction. No-AEP significantly outperforms the monotonous-AEP group (p = .008, Z = 1.541, r = .41) on the receptive vocabulary measure (BPVS SS). While the exaggerated-AEP group scores are higher on the BPVS than the monotonous-AEP group, no significant difference exists between them (p = .575, Z = .802).

The two AEP groups are now combined to examine the overall impact of AEP (regardless of being monotonous or exaggerated) vs. No-AEP on performance on the measures of language and non-verbal cognition. Kolmogorov-Smirnov tests reveal the No-AEP group reaches high significance ($\leq$ .005 after Bonferroni correction) with medium effect sizes in outperforming the combined AEP group on the measures of receptive vocabulary (p = .005, Z = 1.610, r = .36), expressive vocabulary (p = .005, Z = 1.561, r = .35) and expressive language (p = .003, Z = 1.610, r = .36) with a trend toward significance on the measure of receptive grammar (p = .022, Z = 1.415, r = .32). There is no significant difference between those with and without AEP on the measure of non-verbal cognition or articulation skills, however (p = .920, Z = .390; p = .535, Z = .683, respectively).

4.2.2.10 Comparison of HFA Children with and without AEP - Pragmatics

Comparison of the individual AEP groups with the No-AEP group is done separately for the CCC-2 measure, as it reflects a different scale than the other language assessments. This analysis focuses on the measures that are said to assess the pragmatic aspects of communication (Inappropriate Initiation, Stereotyped Language, Use of Context and Nonverbal Communication) as well as the scales that were designed to assess behaviours which are typically impaired in those with ASDs (Social Relations and Interests) (Bishop, 2003b). However, the Kruskal-Wallis test reveals no significant difference in performance for either the individual or combined AEP groups as compared to the No-AEP group.

4.2.2.11 Comparison of HFA Children with and without AEP - PEPS-C

The Kruskal-Wallis test reveals a significant difference between expressive prosody groups on the PEPS-C total score (H (2) 8.656, p = .007), and approaches significance with the PEPS-C input subtests (H (2) 6.886, p = .025) and PEPS-C output subtests (H (2) 7.195, p = .020) with the No-AEP group outranking both AEP groups on each measure. Thus the skills of the children with typical expressive prosody are better than those with either monotonous or exaggerated prosody on the entire prosody assessment. The group with monotonous-AEP have worse receptive (input) prosodic skills than the group with typical expressive prosody whilst the group with exaggerated-AEP have worse expressive (output) prosodic skills than the typical prosody group. Kolmogorov-Smirnov tests are used to compare No-AEP to monotonous-AEP as well as No-AEP to exaggerated-AEP after applying the Bonferroni correction, therefore using a .008 level of significance. None of the results reaches significance, however.

The AEP groups are now combined to examine the overall impact of AEP (regardless of being monotonous or exaggerated) vs. No-AEP on performance on the PEPS-C. Kolmogorov-Smirnov tests reveal the No-AEP group reaches high significance ($\leq .003$ after Bonferroni correction) with medium effect sizes in outperforming the combined AEP group on the Chunking output, Affect output and PEPS-C total score. Table 4-18 presents details of these tests. Note the No-AEP group also approaches significance in outperforming the combined AEP group on the Output subtests. Therefore the PEPS-C assessment appears to confirm that children who have AEP present in their functional, daily communication also have difficulty with grammatical and affective use of prosody within structured tasks. In addition to a lower score on the total PEPS-C, the AEP group shows particular difficulty with the grammatical prosodic function of chunking information, as well as with the expression of affective prosody to indicate likes and dislikes.

Table 4-18. Significance of Children with Typical Expressive Prosody (No-AEP) Group Outperforming the Atypical Expressive Prosody (AEP) Group on Profiling Elements of Prosodic Systems-Children (PEPS-C) Subtests and Total Scores. Significance at the .003 level is indicated by dark shading in the blocks, light shading indicates results that approach significance. NS means no significant differences.

Turn-End Input	Z = 1.171 p =.079 *ns* n = 20	Turn-End Output	Z = 1.269 p =.036 *ns* n = 20
Affect Input	Z = .976 p = .18 *ns* n = 20	Affect Output	Z = 1.533 p = .006 r = .35 n = 20
Intonation Input	Z = .878 p = .153 *ns* n = 20	Intonation Output	Z = 1.073 p = .124 *ns* n = 20
Chunking Input	Z = .537 p = .785 *ns* n = 20	Chunking Output	Z = 1.561 p = .003 r = .35 n = 20
Focus Input	Z = 1.220 p = .027 *ns* n = 20	Focus Output	Z = .878 p = .217 *ns* n = 20
Prosody Input	Z = 1.317 p = .023 *ns* n = 20	Prosody Output	Z = .927 p = .255 *ns* n = 20
Peps Total	Z = 1.688 p = .003 r = .39 n = 19	Gain over Time	Z = .667 p = .76 *ns* n = 18
Input Subtests	Z = 1.269 p = .048 *ns* n = 20	Output Subtests	Z = 1.403 p = .015 r = .32 n = 19

4.2.3 Theory of Mind Assessment Measures

Table 4-19 details the HFA-T2 group mean scores, standard deviations and score ranges for the ToM measures. All 24 (100%) of HFA-T2 participants completed all ToM tasks.

Table 4-19. Group Means, SD and Score Ranges for Each Theory of Mind (ToM) Measure

Measure	N	Min	Max	Mean	SD
Diverse Desires	24	0	1	.92	.28
Diverse Beliefs	24	0	1	.83	.38
Knowledge Access	24	0	1	.58	.50
Contents False-Belief	24	0	1	.54	.51
Hidden Emotion	24	0	1	37.5	.49
Wellman Scale Total	24	1	5	3.25	1.51
Smarties	24	0	1	.54	.51
Chocolate Story	24	0	1	.17	.38
John & Mary	24	0	0	0	0
ToM Aggregate Score	24	1	7	3.96	2.12

4.2.3.1 Wellman Scale

The Wellman scale was designed on a theoretical assertion by Wellman and Liu (2004) that each individual task (Diverse Desires, Diverse Beliefs, Knowledge Access, Contents False Belief, and Hidden Emotion) within the scale would be passed in that respective order, thus reflecting cognitive achievements leading to increasingly sophisticated understanding of ToM. Indeed the HFA-T2 group does pass the tasks in a developmental order. The percentage of the group passing each task, from easiest to most difficult are Diverse Desires (92%), Diverse Beliefs (83.3%), Knowledge Access (58%), Contents False Belief (54%) and Hidden Emotion (37.5%). However, there is variability noted in the individual performances of the participants in the order in which the tasks are passed. Thus 79.17% of the participants (n = 19) follow the developmental pattern observed in the whole HFA group whilst 20.83% (n = 5) follow unique patterns. Examination of those participants who passed all five tasks (n = 7) in the scale reveals that no child passed with a verbal mental age less than 6;01 years, although only one participant at this verbal mental age passed. The other six participants who passed the entire scale all have a verbal mental age greater than 8;08 years.

4.2.3.2 Rasch Model Results

Wellman and Liu (2004) confirmed the developmental progression using their data from typically developing preschool children using a Rasch measurement model. A Rasch model organises dichotomous items and persons on a continuum on which a person with a particular level of ability is apt to respond correctly to items below his/her ability level whilst he/she is likely to respond incorrectly to items beyond his/her ability level (Linacre, 2003; Wellman & Liu, 2004; Doyle, Hula, McNeil, Mikolic & Matthews, 2005). Wellman and Liu used the WINSTEPS programme (Linacre, 2003), specifying that for their analyses "the item difficulty and person ability measures on the linear logits scale were rescaled so that the Contents False Belief (arbitrarily considered as the anchor task of the five tasks) had an item difficulty measure score of 5.0 on the linear scale" (Wellman & Liu, 2004, p. 534). For conformity to the Wellman and Liu (2004) data, the current study uses the same parameters in the WINSTEPS programme, version 3.53 (Linacre, 2003) for Rasch analyses. Table 4-20 shows details of the item measure and error statistics, comparing findings from the current study with those by Wellman and Liu (2004). Both studies find the same order of difficulty on the Rasch model, apparent in the percentage of children passing; thus Hidden Emotion (the top item on the table) is the most difficult, preceded by Contents False-Belief, Knowledge Access, Diverse Beliefs and Diverse Desires.

Table 4-20. Rasch Item Measure Summary (left) and Error Rates per Item (Right); showing comparison between results from current study and those reported by Wellman and Liu (2004)

Measure		
Item		
	Current Study	Wellman & Liu (2004)
Hidden Emotion	7.3	7.73
Contents False-Belief	5	5
Knowledge Access	4.44	3.61
Diverse Beliefs	0.33	2.43
Diverse Desires	-0.38	0.48
Mean	*3.34*	*3.85*
SD	*2.92*	*2.44*

Error		
Item		
	Current Study	Wellman & Liu (2004)
Hidden Emotion	0.84	0.46
Contents False-Belief	0.76	0.35
Knowledge Access	0.78	0.37
Diverse Beliefs	0.81	0.42
Diverse Desires	0.88	0.69
Mean	*0.8*	*0.5*
SD	*0.0*	*0.1*

A principal components analysis of the standardised residuals conducted in WINSTEPS version 3.53 (Linacre, 2003) provides evidence that the Wellman and Liu (2004) ToM scale is indeed measuring a uni-dimensional construct. The variance explained by the ToM scale in the current study is 95.6%; therefore it exceeds the parameters outlined in Linacre (2003) which specifies that to show a uni-dimensional construct, measures should exceed 60% of variance. Likewise, Linacre (2003) specified that the unexplained variance should be less than 3%; in this analysis the unexplained variance is 1.4%.

Examination of the relative distances between item difficulty scores shows a range of difference between consecutive items from between 1 and 3.67 for the current study and between 1.2 and 2.73 in the Wellman and Liu data. Wellman and Liu (2004) asserted that the difference between successive items is not problematic, noting that Rasch measurement does not assume equivalent intervals between items; rather it provides an estimation of the true interval between items measured. The congruence between the item measure statistics across studies provides further evidence that the children with HFA performed like the chronologically younger typically developing children in the study by Wellman and Liu (2004).

However, comparison of the error rates and standardised outfit statistics for both studies shows disparity between findings. Infit statistics are sensitive to unexpected responses close to the item or person measurement level, whilst outfit statistics are more sensitive to unexpected responses that are far away (either too easy or too difficult) from the item or person measurement level (Linacre, 2003; Wellman & Liu, 2004). Wellman and Liu (2004) asserted that standardised infit and outfit statistics for individual items are expected to have a value of 0 with values greater than 2.0 showing greater than expected variation. Table 4-21 presents a comparison of the infit and outfit statistics between the HFA-T2 data and that of the typically developing children obtained by Wellman and Liu (2004). Statistics are presented for each item of the ToM scale, including the mean and standard deviations for the combined infit and outfit values across all items. Almost all individual items achieved the desirable value of less than 2.0; likewise almost all the mean values are close to the expected value of 0. The exception occurs on the outfit value on the Contents False-Belief task in the current study and therefore the mean outfit value also exceeds the acceptable range. Thus for the children with HFA, the Contents False-Belief task was either too easy or too difficult as compared to the adjacent items on the scale. A review of the item and person map generated by the WINSTEPS programme clarifies this finding (see Table 4-22) as it demonstrates that ceiling effects are the cause of the discrepancy. Persons exceed items on each task, as well as on the entire scale, but this is most evident on the Contents False-Belief task. As the scale was designed to be achieved by preschool children, it is not surprising that these older children with HFA show ceiling effects with the scale.

Table 4-21. Rasch Item Measure Fit Statistics for Current Study (left column), with comparison to findings from Wellman and Liu (2004) (right column); the area highlighted in grey indicates underfit with Rasch model

	Standardised Infit-Items	
	Current Study	**Wellman & Liu (2004)**
Hidden Emotion	**-0.02**	**0.1**
Contents False-Belief	**0.68**	**-1.9**
Knowledge Access	**-0.24**	**-0.1**
Diverse Beliefs	**-1.03**	**0.2**
Diverse Desires	**-0.36**	**0.3**
Mean	*-0.2*	*-0.3*
SD	*0.6*	*0.8*
	Standardised Outfit-Items	
	Current Study	**Wellman & Liu (2004)**
Hidden Emotion	**1.47**	**-0.1**
Contents False-Belief	**2.71**	**-1.7**
Knowledge Access	**0.04**	**0.7**
Diverse Beliefs	**0.72**	**0.9**
Diverse Desires	**1.29**	**0.2**
Mean	*1.2*	*0.0*
SD	*0.9*	*0.9*

Table 4-22. Rasch Item Person map from WINSTEPS Programme; both the Persons (left column) and Map of Items (right column) are measured in Logits

	Persons	Map of Items
	<more>	<rare>
8	XXXXXXX	
		Hidden Emotion
7		
	XXXXXX	
6		
5		Contents False Belief
	XX	Knowledge Access
4		
3		
	XXXXX	
2		
1		
		Diverse Beliefs
0	XXXX	
		Diverse Desires
-1		
	<less>	<freq>

4.2.3.3 Smarties Task

Thirteen children (54.2%) passed the Smarties false-belief task, which requires answering the test question (that another person would think sweets, rather than a pencil, was in the Smarties container) as well as a control question (requiring them to recall that they initially thought the container had sweets). Three children correctly answered the test question but failed the control question; therefore they do not receive credit for the Smarties task. Note that 54% of the children also passed the Contents False-Belief task on the Wellman scale, which is a very similar false-belief task in which unexpected objects are in a highly familiar container; however 2 children who failed the Smarties task passed the Wellman Scale Contents False-Belief task and vice versa. Additionally, no child passed the Smarties task with a verbal mental age of less than 6;01 years but most children who passed are at a verbal mental age of 7;04 years or higher.

4.2.3.4 Chocolate Story

In order to pass the Chocolate story task, the child must understand that Simon moved a chocolate bar thinking he was hiding it from his sister, Anne; however unbeknownst to Simon, Anne watched him move the chocolate. Four correct responses are required; the two main questions ask *where* Simon thinks Anne will look for the chocolate and *why* she will look there, whilst the two control questions require recalling where the chocolate was to begin with and where it actually is at the end of the story. Three (12.5%) of the HFA-T2 group answered all questions and thus receive credit for passing the task. One child passed the Chocolate story second-order task at a verbal mental age of 6;01; the other two who passed the same task had a verbal mental age greater than 8;08 years.

4.2.3.5 John & Mary Task

None of the 24 HFA-T2 children (0%) passed this task, however four children (16.67%) were able to correctly identify where Mary thought John would go to buy his ice-cream, although none of them provided a correct answer as to why Mary thought that. Two children came close to a full response; one stated "Cos the ice-cream man said he was going to be in the park all afternoon" and the other said "Because the last time the ice-cream man said he was going to be in the church instead"; however neither child provided detail about what John or Mary thought, thus not fully demonstrating second-order ToM (Baron-Cohen, 1989).

4.2.3.6 Comparison of Performance on Second-Order Tasks

The Chocolate story second-order task was included in the assessment protocol to help elucidate the effects of story length. Both the Chocolate and John & Mary stories have four characters that move between five locations. However, the John & Mary story has 298 words (209 words excluding questions) whilst the Chocolate story is shorter, with 177 words (150 words excluding questions). The script for the Chocolate story is in Appendix V (p. 256) and the script for the John & Mary is provided in Appendix VI (p. 257). Results appear to indicate that story length did affect the results, as three children passed the Chocolate story second-order task but failed the John & Mary task. Additionally, of the 21 children who failed the

Chocolate story task, 16 (66.67%) passed all the memory and control questions. On the John & Mary task, all 24 children failed the task, with 13 children (54.17%) correctly answering all the memory and reality questions and 11 children (45.84%) incorrectly answering at least one memory and/or reality question. A Wilcoxon signed ranks test indicates that the number of children who passed the memory and control questions on the Chocolate story as opposed to those for the John & Mary story approaches significance ($Z = -2.236$, $p = .063$, $r = .46$). Therefore, demands for memory and attention due to story length appear to be factors in the success or failure on such tasks and may mask second-order ToM ability or disability.

4.2.3.7 Aggregate Scores

Scores from the Wellman scale, Smarties task, Chocolate story and John & Mary story are combined to create a robust aggregate score for analyses (Hughes et al., 2000; Hale & Tager-Flusberg, 2005); the highest possible score is 8. Table 4-23 compares performance across all ToM tasks by each participant and illustrates the individual variability within the HFA group.

Table 4-23. ToM Aggregate Score Distribution; the highest possible score is 8. Shaded blocks indicate passing individual tasks with light shading for Wellman Scale tasks, medium shading for 1st order task and dark shading for 2nd order tasks passed. Note no participants passed the John & Mary task. The left columns show the chronological age (Chron Age) in years and verbal mental age in years as determined by the British Picture Vocabulary Scale (BPVS)

Chron Age	BPVS AE	Diverse Desires	Diverse Beliefs	Knowledge Access	Contents False Belief	Hidden Emotion	Wellman Scale Total	Smarties	Chocolate Story	John & Mary Story
12.33	5.83						4			
11.75	5.42						2			
15.33	5.67						1			
12.58	5.92						3			
9.67	5.92						2			
12.33	6.08						5			
11.83	6.58						1			
9.08	6.67						3			
13.17	6.83						1			
11	6.83						2			
10.5	7.33						4			
8.58	7.33						3			
9.42	7.50						2			
15.75	7.50						4			
11.25	7.92						2			
14.5	8.33						1			
9	8.67						5			
10.75	8.67						5			
10	8.83						5			
14.5	9.75						4			
10	11.08						5			
14.58	12.83						5			
11.92	14.42						5			
16	16.17						4			
# Passing task		22/24	20/24	14/24	13/24	9 /24	3.25	13/24 P	3/24 P	0/24 P
%Passing task		92%	83.3%	58%	54%	37.5%	1.51	54%	12.5%	0%

4.2.3.8 ToM Scores by Language Impairment Profiles

Table 4-24 presents the means and standard deviations by presence and type of language impairment for all ToM scores. The Kruskal-Wallis test reveals a significant difference between the groups on Knowledge Access task (H (3) 8.796, p = .014), the Hidden Emotion task (H (3) 7.903, p = .031), Wellman Scale total score (H (3) 8.366, p = .020) and the ToM aggregate score (H (2) 7.512, p = .037) with the WNL and receptive-and-expressive-impairment groups achieving the highest and lowest rankings, respectively. Follow-up Kolmogorov-Smirnov tests are used to compare these two groups after applying the Bonferroni correction, therefore using a .012 level of significance. However, the tests show that the WNL group does not reach significance in outperforming the receptive-and-expressive-impairment group.

Table 4-24. ToM Scores by Impairment Profiles; shaded areas indicate mean scores for each group

Group		Diverse Desires	Diverse Beliefs	Knowledge Access	Contents False-Belief	Hidden Emotion	Wellman Scale Total	Smarties	Chocolate story	John & Mary	ToM aggregate
Expressive-Impairment-only	N	6	6	6	6	6	6	6	6	6	6
	Mean	**1**	**1**	**0.83**	**0.67**	**0.50**	**4**	**0.67**	**0.33**	**0**	**5**
	SD	0	0	0.41	0.52	0.55	1.27	0.52	0.52	0	2.10
Receptive-Impairment-only	N	2	2	2	2	2	2	2	2	2	2
	Mean	**1**	**1**	**1**	**0.5**	**0.5**	**4**	**0.5**	**0**	**0**	**4.5**
	SD	0	0	0	0.71	0.71	1.41	0.71	0	0	2.12
Receptive-and-expressive-Impairment	N	13	13	13	13	13	13	13	13	13	13
	Mean	**0.85**	**0.69**	**0.31**	**0.46**	**0.15**	**2.46**	**0.38**	**0.08**	**0**	**2.92**
	SD	0.38	0.48	0.48	0.52	0.38	1.39	0.51	0.28	0.00	1.85
Within Normal Limits	N	3	3	3	3	3	3	3	3	3	3
	Mean	**1**	**1**	**1**	**0.67**	**1**	**4.67**	**1**	**0.33**	**0**	**6**
	SD	0	0	0	0.58	0	0.58	0	0.58	0	1.00
All HFA	N	24	24	24	24	24	24	24	24	24	24
	Mean	**0.92**	**0.83**	**0.58**	**0.54**	**0.38**	**3.25**	**0.54**	**0.17**	**0.00**	**3.96**
	SD	0.28	0.38	0.50	0.51	0.49	1.51	0.51	0.38	0.00	2.12

4.2.3.9 Comparison of AEP Groups on ToM and PEPS-C

The Kruskal-Wallis test reveals a significant difference between the No-AEP, monotonous-AEP and exaggerated-AEP groups on the Wellman Scale total score ($H(2)$ 9.587, p = .004), and the ToM aggregate score ($H(2)$ 10.382, p = .002) with the No-AEP group outranking both AEP groups on each measure. Kolmogorov-Smirnov tests are used to compare the groups after applying the Bonferroni correction, therefore using a .008 level of significance.

No-AEP significantly outperforms the exaggerated-AEP group on both the Wellman scale (p = .005, Z = 1.498, r = .42) and the ToM aggregate score (p = .005, Z = 1.498, r = .42). Therefore the most significant difference is apparent between the ToM skills of the children with exaggerated prosody as compared to those with typical expressive prosody.

The monotonous and exaggerated AEP groups are now combined to compare results of their performance on the ToM tasks with those of the No-AEP group. Kolmogorov-Smirnov tests reveal the No-AEP group reaches high significance ($\leq$ .006 after Bonferroni correction) with medium effect sizes in outperforming the combined AEP group on the Hidden Emotion task (p = .001, Z = 1.757, r = .36), the Wellman Scale total score (p = .006, Z = 1.561, r = .32) and the ToM aggregate score (p = .005, Z = 1.561, r = .32). Additionally, the No-AEP group approaches significance in outperforming the AEP group on the Chocolate Story task ($p = .018$, $Z = 1.025$, $r = .21$).

4.2.3.10 ToM Correlations with Language, Chronological Age, Non-Verbal Cognition and Pragmatic Ability

Results reveal significant correlations between ToM and language (Spearman's rho, 2-tailed). Both the Wellman scale and the ToM aggregate scores show significant correlations with vocabulary, receptive grammar and expressive language ability. Neither the Wellman scale nor the ToM aggregate score correlates with non-verbal cognition (RPM) or articulation skills (GF). The ToM aggregate score reveals a significant negative correlation with the CCC-2 Social Interaction Deviance Composite (SIDC). Higher ToM scores occur as the SIDC decreases. Table 4-25 presents the correlation coefficients and significance levels for these findings. Additionally, significant correlations occur between several of the individual ToM tasks with scores for the vocabulary, receptive grammar and expressive language measures. Neither chronological age nor non-verbal cognitive ability shows correlation with any of the individual ToM tasks. These results are presented in Table 4-26 and show that there are significant correlations between the measures of vocabulary (expressive and receptive), receptive grammar and expressive language with the Knowledge Access, Hidden Emotion task and Smarties tasks. The only correlation with the second-order Chocolate Story task occurs with the receptive grammar score. As with the combined ToM scores, significant negative correlations appear between the Social Interaction Deviance Composite and four individual ToM tasks.

4.2.3.11 ToM Correlations with Prosody

Table 4-29 presents significant correlations which exist between individual subtests/tasks, as well as combined scores, on the measures of ToM and prosody (Spearman's rho, 2-tailed). The most significant relationships exist between ToM and the majority of the prosodic output tasks. The Hidden Emotion task from the Wellman Scale shows a particularly strong relationship with prosody. There is no significant relationship between the following tasks/subtests: Diverse Desires, Chocolate Story, Turn-End Input, Affect Input, Intonation Input or Focus Input. Figure 4-12 presents a comparison of the HFA-T2 group's aggregate ToM scores with total scores from the PEPS-C. There is a strong upward trend revealing that as ToM scores increase, so do PEPS-C scores.

Table 4-25: Correlations between Language, Pragmatic and Non-Verbal Cognition Scores with Combined ToM Scores; lightly shaded areas indicate significance at α level (<.05), darkly shaded areas indicate significance at <.01 and blank cells indicate no significance (Spearman's Rho 2-tailed)

	Wellman Scale	ToM Aggregate
Chronological Age		
British Picture Vocabulary Scale – Standardised Score	.606 $p = .002$	.593 $p = .002$
Expressive One-Word Receptive Vocabulary Test – Standardised Score	.641 $p = .001$	.645 $p = .001$
Clinical Evaluation of Language Fundamentals (CELF-3) Expressive Subtests – Standardised Score	.476 $p = .022$	.437 $p = .037$
Test for Reception of Grammar-2 (TROG-2) Standardised Score	.694 $p < .001$	.720 $p < .001$
Goldman-Fristoe Test of Articulation (GF) Standardised Score		
Raven's Progressive Matrices (RPM) Standardised Score		
General Communication Composite (GCC) from the Children's Communication Checklist-2 (CCC-2)		
Social Interaction Deviance Composite (SIDC) from the (CCC-2)	-.517 $p = .014$	-.546 $p = .009$

Table 4-26: Correlations between Language, Pragmatic and Non-Verbal Cognition Scores with Individual ToM Tasks; lightly shaded areas indicate significance at α level (<.05), darkly shaded areas indicate significance at <.01 and blank cells indicate no significance (Spearman's Rho 2-tailed)

	Diverse Desires	Diverse Beliefs	Knowledge Access	Contents False Belief	Hidden Emotion	Smarties	Chocolate Story
Chronological Age							
Raven's Progressive Matrices							
British Picture Vocabulary Scale (BPVS) Standardised Score			.581 $p = .003$		.629 $p = .001$	.496 $p = .014$	
Expressive One-Word Vocabulary Test (EOWPVT-R) Standardised Score			.648 $p = .001$		.610 $p = .002$	.569 $p = .004$	
Clinical Evaluation of Language Fundamentals - 3UK (CELF-3) Standardised Score			.511 $p = .013$		.470 $p = .024$		
Test for Reception of Grammar -2 (TROG-2) Standardised Score			.663 $p < .001$		.606 $p = .002$	.595 $p = .002$	.487 $p = .016$
Children's Communication Checklist - 2 - General Communication Composite							
Children's Communication Checklist - 2 - Social Interaction Deviance Composite			-.485 $p = .022$	-.540 $p = .009$	-.424 $p = .05$	-.678 $p = .001$	

Table 4-27: Correlations between Prosody and ToM; lightly shaded areas indicate significance at α level (<.05), darkly shaded areas indicate significance at <.01 and blank cells indicate no significance (Spearman's Rho 2-tailed). There are no significant relationships between the any of the following tasks: Diverse Desire, Chocolate story (ToM tasks), Turn-End Input, Affect Input, Intonation Input or Focus Input (Prosody subtests); therefore they are not shown on the table

		Diverse Belief	Knowledge Access	Contents False Belief	Hidden Emotion	Wellman Scale Total	Smarties	ToM Aggregate Score
Turn-End Output	corr co				.486			
	sig				.030			
	n				20			
Affect Output	corr co				.670	.508		.469
	sig				.002	.026		.043
	n				19	19		19
Intonation Output	corr co			.652	.447	.549		.530
	sig			.002	.048	.012		.016
	n			20	20	20		20
Chunking Input	corr co	-.445						
	sig	.043						
	n	21						
Chunking Output	corr co				.598			
	sig				.005			
	n				20			
Focus Output	corr co	.564	.478			.449		.453
	sig	.010	.033			.047		.045
	n	20	20			20		20
Prosody Input	corr co				.592			
	sig				.005			
	n				21			
Prosody Output	corr co				.499	.527		.493
	sig				.025	.017		.027
	n				20	20		20
PEPS-C Total	corr co				.672	.517		.504
	sig				.002	.023		.028
	n				19	19		19
Input Subtests	corr co				.535			
	sig				.012			
	n				21			
Output Subtests	corr co		.518		.721	.701	.479	.684
	sig		.023		.000	.001	.038	.001
	n		19		19	19	19	19

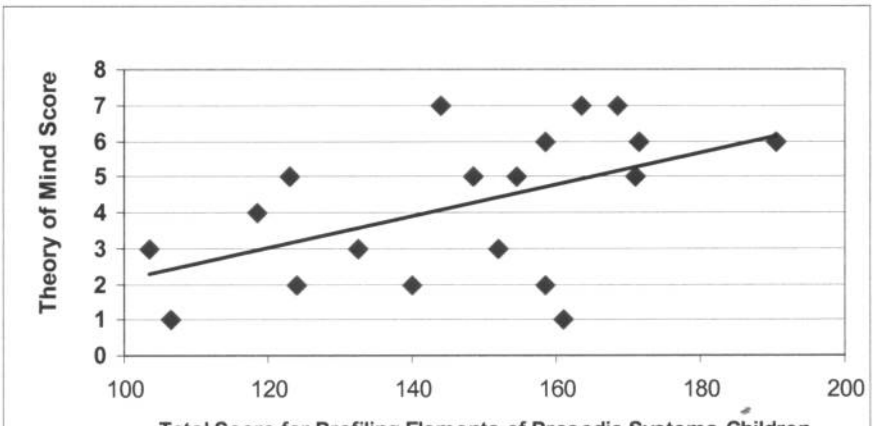


Figure 4-12. Comparison of Aggregate Theory of Mind Scores and Scores from Profiling Elements of Prosodic Systems – Children

4.2.3.12 Relationship between Prosody and ToM Independent of Language

As has been revealed, strong correlations exist between language and prosody as well as between language and ToM; significant correlations also exist between ToM and prosody. To determine whether or not all these relationships exist due to the effects of language ability, a partial correlation which controls for the effects of language is undertaken. The BPVS is used as the main measure of language, as it was also used as a measure of verbal mental age. Partial correlations in SPSS use parametric correlations (Pearson's R). Therefore, correlations between the PEPS-C, Wellman Scale score and ToM aggregate are undertaken with both Spearman's Rho and Pearson's R and results confirm they correlate similarly as shown in Table 4-28. ToM and PEPS-C scores are then analysed using Pearson's correlation and controlling for the BPVS raw score variable at T2 (King et al., 2000). Table 4-29 presents results of correlations after controlling for the effects of language skills. There is a significant relationship between performance on the combined output tasks of the PEPS-C and both the Wellman scale total score as well as the ToM aggregate score which is independent of language ability, however the significant correlations between the total PEPS-C score and the ToM scores disappear after controlling for the effects of language.

Table 4-38. Correlation Table Comparing Pearson and Spearman Coefficients and Significance Values for Theory of Mind Scores and Prosody Total, Input and Output Scores; cells highlighted in grey indicate Pearson's correlations with ** indicating significance at ≤.01 and * indicating ≤.05.

		PEPS-C Total Time 2	PEPS-C Input	PEPS-C Output
Wellman Scale Total	**Pearson Correlation**	**.491**	**.200**	**.642**
	Sig. (2-tailed)	**.033 ***	**.385**	**.003 ****
	N	**19**	**21**	**19**
	Spearman Correlation	*.517*	*.234*	*.701*
	Sig. (2-tailed)	*.023 **	*.308*	*.001 ***
	N	*19*	*21*	*19*
ToM aggregate score	**Pearson Correlation**	**.510**	**.243**	**.645**
	Sig. (2-tailed)	**.026 ***	**.289**	**.003 ****
	N	**19**	**21**	**19**
	Spearman Correlation	*.504*	*.225*	*.684*
	Sig. (2-tailed)	*.028 **	*.327*	*.001 ***
	N	*19*	*21*	*19*

Table 4-29. Partial Correlation Analysis Results Using Pearson's Correlations and Controlling for Language; a relationship remains between output subtests of Profiling Elements of Prosodic Systems-Children (PEPS-C) and measures of Theory of Mind at ≤.05

Control Variable			PEPS-C Total Time 2	PEPS-C Input Subtests Time 2	PEPS-C Output Subtests Time 2
British Picture Vocabulary scale raw score time 2	Wellman Scale Total	Correlation	.209	-.222	.491
		Significance (2-tailed)	.406	.346	.039
		df	16	18	16
	ToM aggregate score	Correlation	.201	-.198	.477
		Significance (2-tailed)	.425	.404	.045
		df	16	18	16

4.2.3.13 Regression Analyses

To determine if particular variables reliably predict presence or absence of atypical expressive prosody, logistic regression analyses are undertaken. First, individual variables are entered in SPSS using the following path: Analysis, Regression, Binary logistic with Type of prosody as the dependent variable. In the first instance, receptive vocabulary (BPVS) is entered as the only covariate. Next, ToM aggregate is entered as the only covariate, followed by PEPS-C total score as the only covariate, then PEPS Input as the sole covariate and finally PEPS Output as the only covariate. At each step the method used is Enter, which is "the only appropriate method for theory testing" (Field, 2005, p. 226). Only PEPS Input and PEPS Output show a significant model for predicting presence or absence of atypical expressive prosody, a shown in Table 4-30. To follow up this finding, both PEPS Input and PEPS Output total scores are entered in a single analysis as covariates, with atypical expressive prosody as the dependent variable. A Backward Stepwise (Wald) regression is used to determine if together they form a better predictive model (Field, 2005). Details are shown in Table 4-31 and 4-32. Only the PEPS-C Output subtests score remains as a significant predictor of presence or absence of atypical expressive prosody, which it does in 84.2% of cases.

Table 4-30: Results Table for Logistic Regression Analysis; the shaded areas represent independent variables that significantly predict presence or absence of atypical expressive prosody (AEP)

	B	SE	Wald	df	Sig.	exp b	R^2	95% CI for exp b Lower	Upper
Constant	-.847	.488	3.015	1	.082	.429			
BPVS raw	.216	.127	2.913	1	.088	1.241	.771	.968	1.591
ToM aggregate	2.395	1.268	3.567	1	.059	10.963	.772	.914	131.542
Peps Total	.150	.081	4.680	1	.063	1.161	.772	.992	1.360
Peps Input	.146	.067	4.760	1	.029	1.158	.479	1.015	1.321
Peps Output	.230	.116	3.889	1	.049	1.258	.550	1.001	1.580

Table 4-31: Results for Stepwise Logistic Regression Analysis in which Input and Output Scores from Profiling Elements of Prosodic Systems-Children (PEPS-C) are in the same model; only Output scores remain as significant predictors of presence or absence of atypical expressive prosody

		B	SE	Wald	df	Sig.	exp b	95% CI for exp b Lower	Upper
Step 1	Peps Input	.124	.091	1.873	1	.171	1.133	.948	1.353
	Peps Output	.264	.171	2.376	1	.123	1.302	.931	1.822
	Constant	-31.180	17.799	3.069	1	.080	.000		
Step 2	Peps Output	.230	.116	3.889	1	.049	1.258	1.001	1.580
	Constant	-18.572	9.286	4.000	1	.046	.000		

Table 4-32: Results Table for Stepwise Logistic Regression Analysis using Input and Output Scores from Profiling Elements of Prosodic Systems-Children (PEPS-C); details are provided for the significance values, Chi-square and degrees of freedom (df)

		Chi-square	df	Sig.
Step 1	Step	11.854	2	.003
	Block	11.854	2	.003
	Model	11.854	2	.003
Step 2	Step	-2.407	1	.121
	Block	9.448	1	.002
	Model	9.448	1	.002

4.2.4 Summary of Language, Prosody and ToM Skills at T2

The previous section presented the current status of the HFA-T2 group including the language, prosody and theory of mind scores, group means and differences noted between them. In this section, a summary of the main findings of the HFA-T2 group are presented.

4.2.4.1 Language

The main language findings are as follows:

- As a group, participants' age equivalent scores are significantly below their chronological age; however, mean standard scores are within the average range (within 1.5 SD from population mean) for non-verbal cognition, articulation, expressive single word vocabulary and receptive grammar;
- As a group, mean standard scores are within the impaired range (more than 1.5 SD below the mean) on receptive vocabulary and expressive language; however, individually, the majority of the HFA-T2 participants are within the average standard score range (within 1.5 SD) on measures of receptive vocabulary, articulation and non-verbal cognition; whilst there are equal numbers of participants scoring within and outwith the average score range on the receptive grammar and expressive vocabulary measures;
- Scores for pragmatic skills are in the impaired range for all participants; therefore pragmatics are the most consistently impaired skill;
- All participants have scores in the average to above-average range (70 to 125) on the assessment of non-verbal cognition;
- Individual profiles reveal 54% of the 24 participants show combined receptive-and-expressive-language impairment.

4.2.4.2 Prosody

The main findings are as follows:

- As a group, the competency level was met or surpassed on 7/12 subtests; individually, the majority of children (59%) surpassed the competency level on the entire PEPS-C assessment, whilst 32% (n = 7) showed a mild impairment (scored within 1.5 SD of competency level) and 9% (n = 2) showed a severe impairment (score more than 1.5 SD below competency level);
- Vocabulary and expressive language skills correlate significantly with prosodic ability; however, articulation skills, chronological age and pragmatic ability do not correlate with any PEPS-C scores;

- 14 of 20 participants (70%) are judged to have atypical expressive prosody (AEP), which presents as excessively variable/exaggerated in seven participants and as excessively limited in variability/monotonous in seven participants;
- The No-AEP group significantly outperforms the combined AEP groups on the measures of receptive and expressive vocabulary as well as expressive language; however, no significant difference appears between the AEP groups (both individually and combined) and the No-AEP group on the measure of pragmatic ability;
- The No-AEP group significantly outperforms the combined AEP group on expressive grammatical and affective subtests on the PEPS-C and on the total PEPS-C score;
- Regression analysis reveals Output subtests of the PEPS-C assessments predicts presence or absence of AEP in 84% of participants.

4.2.4.3 Theory of Mind

Analyses of ToM results reveal the following main findings:

- As a group, the 24 participants follow the same developmental progression of skills on the ToM scale as do typically developing children;
- Significant correlations exist between ToM skills and language (BPVS, EOWPVT, TROG-II & CELF-3), ToM and pragmatics (SIDC score on the CCC-2) and ToM and expressive prosody (combined PEPS-C output tasks); however, no correlation is found between ToM and articulation ability, non-verbal cognitive skills (RPM), or chronological age;
- Results from the second-order tasks indicate the HFA-T2 group has a significant impairment with this skill; comparison of results between the Chocolate story and John & Mary tasks indicate that story length is a factor on success or failure on second-order ToM skills;
- The children with typical expressive prosody had significantly higher Wellman scale and ToM aggregate scores than did the group of children

with exaggerated atypical expressive prosody (AEP), as well as the combined AEP groups;

- A significant relationship exists between the group scores on the expressive output subtests of the PEPS-C and the ToM scores after controlling for the effects of language.

4.3 HFA: DEVELOPMENT AND CHANGE OVER TIME

In this section, data for the 24 HFA-T2 children will be compared with the results gathered at Time point 1 (HFA-T1). The HFA-T1 data are from a study entitled "Prosodic Ability in Children with Autism" which was completed in 2004 at Queen Margaret University College, funded by the Chief Scientist Office (CSO) of the Scottish Executive (Peppé & McCann, 2003; Gibbon et al., 2004; Peppé et al., in press; McCann et al., in press)

4.3.1 Language

4.3.1.1 Participants

HFA-T1 is comprised of 31 participants (24 male, 7 female) who range in chronological age from 6.08 to 13.5 years (*M* 9.78, *SD* 2.33). Seven of these children did not participate in the T2 data collection.

4.3.1.2 Time Elapsed between Testing at T1 and T2

The amount of time between assessments at T1 and T2 ranges from 1.5 to 2.58 years (*M* 2.25 years, *SD* .29). Non-parametric correlation tests (Spearman's rho, 2-tailed) indicate no significant effects exist due to differences in the amount of time elapsed between testing and results of any of the T2 measures.

4.3.1.3 Different Test Versions

At T1, original versions of the Test for Reception of Grammar (TROG) and the Children's Communication Checklist (CCC) were used; at T2 revised versions of both these tools were used. The TROG and TROG-II use a standardised score that can be compared across time, however the raw scores cannot because the original

TROG had a set of warm-up items that were eliminated in the revised version and resulting in an increased difficulty range (Bishop, 2003a). The CCC and CCC-2 provide different scores altogether and cannot be compared. Further, expressive vocabulary and ToM abilities were not assessed at T1. All 31 participants completed the BPVS, GF and TROG; 28 of 31 participants (90.32%) completed the CELF-3; 29 of 31 completed the RPM (93.54%) and CCC questionnaires were completed for 27 of 31 participants (87.1%).

4.3.1.4 HFA Group Language Scores T1 - T2

Table 4-33 provides the group mean scores, standard deviations and ranges for these measures at T1 and T2; Figure 4-13 compares mean standard scores over time. Note that the group mean standard scores remain relatively stable, with a slight decrease over time for all measures except the CELF-3 which shows a slight increase. These results are encouraging as this HFA group is neither losing nor gaining ground with their typically developing peers; rather they appear to be developing skills along the same (albeit delayed) trajectory.

Table 4-33. Comparison of HFA-T1 and HFA-T2 Group Means and Standard Deviations; shaded areas indicate Standard Scores

Assessment Measure	HFA-T1 Mean	SD	HFA-T2 Mean	SD
British Picture Vocabulary Scale (BPVS) Age Equivalent	7.03	2.01	8.22	2.82
BPVS Raw Score	71.55	19.32	79.96	22.35
BPVS Standard Score	**80.13**	**17.80**	**75.42**	**20.28**
Clinical Evaluation of Language Fundamentals-3UK (CELF-3) Expressive Subtests Age Equivalent	5.60	1.26	6.44	0.94
CELF-3 Raw Score	46.21	23.94	55.22	29.04
CELF-3 Standard Score	**70.72**	**8.80**	**71.43**	**10.66**
Goldman-Fristoe Test of Articulation (GF) Raw Score	4.77	11.49	4.04	9.17
GF Standard Score	**94.32**	**17.93**	**92.83**	**20.1**
Test for Reception of Grammar (TROG) – Time 1 (TROG-2) – Time 2 Raw Score	12.45	4.11	11.88	4.78
TROG (Time 1) /TROG-2 (Time 2) Standard Score	**81.03**	**17.88**	**79.13**	**18.25**
Raven's Progressive Matrices (RPM) Age Equivalent	8.83	2.03	10.1	2.23
RPM Raw Score	27.34	8.16	30.46	6.79
RPM Standard Score	**94.66**	**15.17**	**93.46**	**19.17**

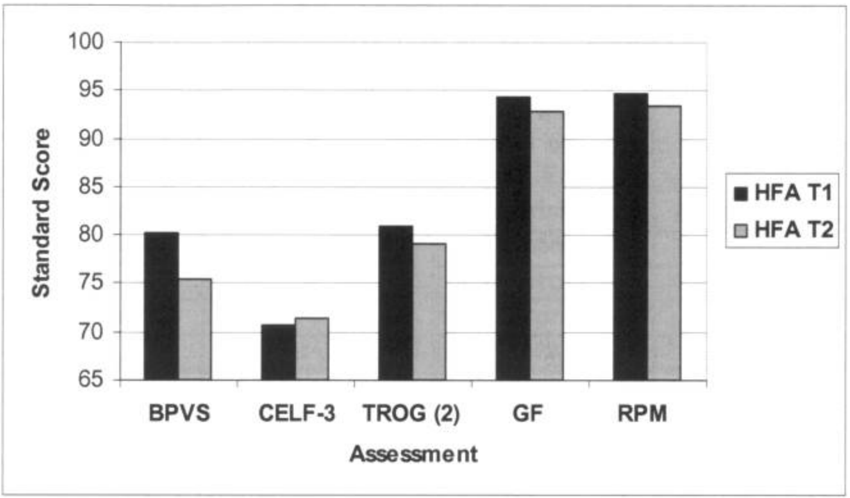


Figure 4-13. Comparison of Group Mean Standard Scores for Language Assessments over Time. (BPVS=British Picture Vocabulary Scale; CELF-3=Clinical Evaluation of Language Fundamentals-3; TROG=Test for Reception of Grammar (at Time 1); TROG-2=Test for Reception of Grammar -2 (at Time 2); GF=Goldman-Fristoe Test of Articulation; RPM=Raven's Progressive Matrices)

4.3.1.5 BPVS

Paired-t tests reveal no significant difference between the BPVS standard score (*df* 23, $p = .123$) at T1 vs. T2. However, Wilcoxon tests do reveal a significant gain in the BPVS raw score ($z = -3.402$, $p > .001$, effect size .46) and BPVS age equivalent scores ($z = -3.687$, $p > .001$, effect size .50).

4.3.1.6 CELF-3

Similarly, improvement is observed in the CELF-3 raw (paired t-tests, *df* 22, $p = .001$, effect size .75) and age equivalent scores using Wilcoxon tests ($z = -3.926$, $p < .001$, effect size .53), but there is no significant change on the CELF-3 standard score (z = -.156, $p = .891$).

4.3.1.7 Goldman-Fristoe

Significant improvement is revealed in the GF raw score ($z = -3.097$, $p < .001$, effect size .42). 17 of 31 participants (54.83%) had errors at T1 ($M = 4.77$ errors, $SD = 11.49$) and 9 of 24 participants (37.5%) have errors at T2 ($M = 4.04$ errors, $SD = 9.17$). However, no significant difference is noted in the GF standard score (z = -.781, $p = .447$). Table 4-34 compares the number of speech errors from T1 to T2.

Table 4-34. Comparison of Number of Speech Errors from T1 to T2 (From Goldman-Fristoe Test of Articulation - raw score)

HFA-T1 Total Number of Speech Errors per Particpant	*N*	% of Total	HFA-T2 Total Number of Speech Errors per Participant	*N*	% of Total
> 15 errors	2	6.45	> 15 errors	1	4.17
11-15 errors	1	3.23	11-15 errors	2	8.33
6-10 errors	3	9.68	6-10 errors	2	8.33
1-5 errors	11	35.48	1-5 errors	4	16.67
0 errors	14	45.16	0 errors	15	62.5
	31	100		24	100

Gibbon et al. (2004) reported on the qualitative single word speech production differences among the HFA participants at T1 using a classification scheme which codes articulation errors as either minor variations, almost mature, immature, very immature or atypical (Anthony, Bogle, Ingram & McIsaac, 1971), with atypical productions indicating deviance. One child had 60 errors at T1 which consisted of many immature and very immature phonological process errors such as cluster reductions, final consonant deletions and fronting. However the same participant also produced atypical substitutions such as /çi/ for 'tree' and /we/ for 'ring' (Anthony et al., 1971). At T2, the same child has 42 errors; the gain noted is mostly due to an increased use of final consonants, yet the atypical substitutions remain. Another child produced phoneme specific nasal emission, which is an atypical phonological process (Anthony et al., 1971) error, at T1 with no improvement noted at T2 (e.g., /fŋɪmɪn/ for 'swimming'). Both participants continue to have severely reduced intelligibility at T2; this finding concurs with the statement by Tager-Flusberg et al. (2005) that a small number of children with HFA have "extraordinary difficulties in producing intelligible speech" (pp. 343-344). Other participants had 'almost mature' errors (Anthony et al., 1971) at T1 which are no longer present at T2. Thus, even though single word articulation skills represent the strongest area of ability in this group of children with HFA, abilities are heterogeneous among the participants who are noted to have speech errors at either or both Time points.

4.3.1.8 TROG and TROG-2

The TROG and TROG-2 raw scores cannot be compared because they contain different items; however no significant difference is noted in the standard scores over time (paired t-tests, *df* 23, p = .463), indicating no group improvement in receptive grammatical skills.

4.3.1.9 RPM

Significant improvement is revealed in the RPM raw scores (Wilcoxon signed ranks, z = -3.451, p < .001, effect size .47) and age equivalent scores (z = -3.706, p < .001, effect size .50) but no significant difference is noted in the RPM standard score (z = -1.423, p = .163). These results indicate that non-verbal cognitive skills remain stable over time for the HFA-T2 group. This is what is expected for typically developing children as well (Mackintosh, 1998). However, individual variability is particularly notable in the change of skills over time. 25% of the participants (n = 6) show a gain (mean gain 7.17 points) in non-verbal cognitive skills, 29.17% have stable scores over time (n = 7) and 45.83% show a decrease (mean loss 11.81 points) in non-verbal cognitive skills (n = 11). Figure 4-14 illustrates the standard score changes over time by individual participants.

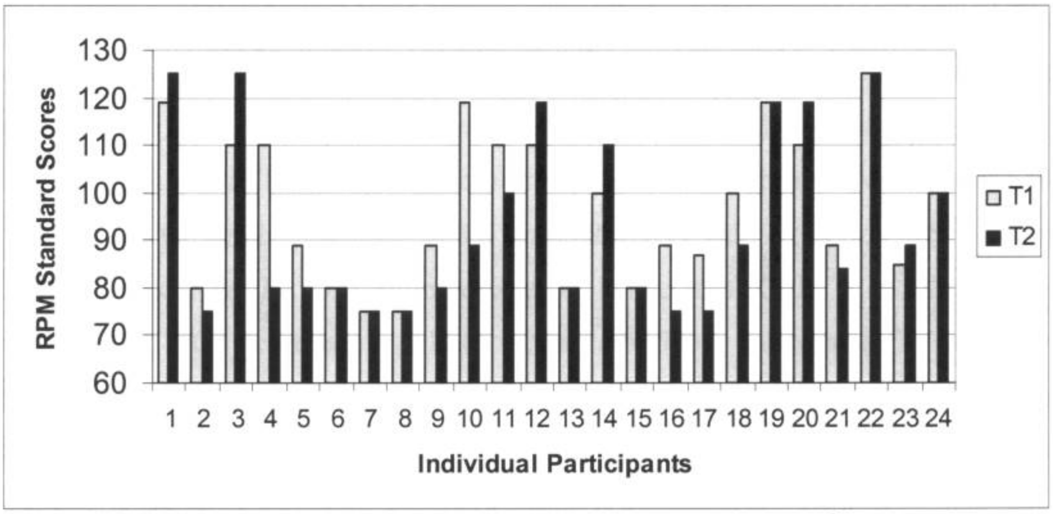


Figure 4-14. Raven's Progressive Matrices (RPM) Standard Score Changes over Time, illustrating development of non-verbal cognition

4.3.1.10 CCC and CCC-2

The teachers or speech language therapists of 27 of 31 (87.10%) participants completed the CCC checklist at T1. McCann et al. (in press) reported that 74% of the HFA-T1 children had a score below the pragmatic composite cut-off, indicating impaired pragmatic ability. Of the 26% that scored above the impaired range, 10% scored at a level consistent with that expected for typically developing children (McCann et al., in press); although Bishop and Baird (2001) asserted that there should be very little overlap in scores between TD children and those with clinically significant communication problems. Thus, McCann et al. (in press) questioned the ability of the CCC to reliably identify pragmatic impairment.

At T2, 21 of 22 (95.45%) participants present a score on the General Communication Composite which is consistent with what is expected for children with ASDs. Therefore, the CCC-2 appears to be an improved tool in identifying or confirming the presence of pragmatic difficulties. Because a different version of the checklist is used at T2, no direct comparison can be made; however results at both time points indicate the majority of participants show impaired pragmatic skills.

4.3.1.11 Correlations between Language Measures

Table 4-35 presents correlations found between language measures at T1 (using Pearson's correlation). T2 correlations are undertaken with Spearman's rho. The same negative correlation occurs at T1 and T2 between the BPVS and chronological age (at $\leq .05$) and between RPM and chronological age (although at T1 it is at the level of $\leq .01$ and at T2 $\leq .05$). At both time points, similar positive correlations are noted (at $\leq .01$ levels) between BPVS and TROG as well as between BPVS and CELF-3. There was no correlation noted at T1 between the CELF-3 and the TROG, however at T2 they correlate highly (p = .006, r = .553). Likewise at T1 there was no correlation between pragmatic ability and RPM or pragmatic ability and chronological age, but there is at T2; this may be a result of the CCC-2 being a more accurate measure of pragmatic ability in children with HFA.

Table 4-35. Correlation Matrix of Language and Non-Verbal Cognition Standard Scores at T1 (from McCann et al., in press); darkly shaded areas indicate correlations at $\leq .01$ and lightly shaded areas indicate significance at $\leq .05$

		CA	BPVS	CELF-3	TROG	GF	RPM	CCC
Chronological Age (CA)	**Corr Co**		**-.402**				**-.480**	
	Sig.		**.025**				**.007**	
	N		**24**				**24**	
British Picture Vocabulary Scale (BPVS)	**Corr Co**	**-.402**		**.589**	**.631**			
	Sig.	**.025**		**<.001**	**<.001**			
	N	**24**		**31**	**31**			
Clinical Evaluation of Language Fundamentals-3 UK (CELF-3) Expressive Subtests	**Corr Co**		**.589**					**.412**
	Sig.		**<.001**					**.041**
	N		**31**					**31**
Test for Reception of Grammar (TROG)	**Corr Co**		**.631**					**.382**
	Sig.		**<.001**					**.049**
	N		**31**					**31**
Goldman-Fristoe Test of Articulation (GF)	**Corr Co**							
	N							
Raven's Progressive Matrices (RPM)	**Corr Co**	**-.480**						
	Sig.	**.007**						
	N	**24**						
Children's Communication Checklist (CCC)	**Corr Co**			**.412**	**.382**			
	Sig.			**.041**	**.049**			
	N			**31**	**31**			

4.3.1.12 Significant Differences between Language Measures at T1 versus T2

At T1, mean group scores on the CELF-3 were significantly lower than those on the TROG or BPVS (McCann et al., in press); at T2 the CELF-3 mean group score also ranks as the lowest score of the three. Additionally, at both T1 and T2 the GF (articulation) and RPM (non-verbal cognition) show the highest scores of all the measures. At T2 the RPM is significantly higher than the BPVS (p = .001, z = -3.272, effect size .47) and the CELF-3 (p < .001, z = -4.078, effect size .59), the GF is significantly higher than the CELF-3 (p = .001, z = -3.347, effect size .48) and no significant difference exists between articulation ability and non-verbal cognition. Although exact quantitative comparisons cannot be made due to a difference in statistical methods used, it is clear that a similar profile remains at T2, with single-word articulation and non-verbal cognitive skills as relative strengths whilst receptive vocabulary, receptive grammar and pragmatic ability are areas of deficit, with expressive language the most severely impaired skill.

4.3.1.13 Language Impairment Profiles T1 – T2

The same method of determining presence and type of language impairment used with the HFA-T2 group is used here with the HFA-T1 data to ascertain whether changes in profiles have occurred. The percentage of children with combined expressive-and-receptive-impairments is quite similar at both time points (56.67% at T1, 54.17% at T2). Change is noted in the group of children with expressive-only-impairment; this group's membership decreases over time (33.33% at T1, 25% at T2) while the percentage of children with receptive-only-impairment increases (3.33% at T1, 8.33% at T2). The most encouraging change is seen in the WNL group which increases from 2 participants at T1 (6.67%) to 3 participants at T2 (12.5%). Figure 4-15 illustrates the group membership at T1 (for reference to these profiles at T2, see Figure 4-9, p. 130). Figure 4-16 presents the changes in presence and type of language impairments over time.

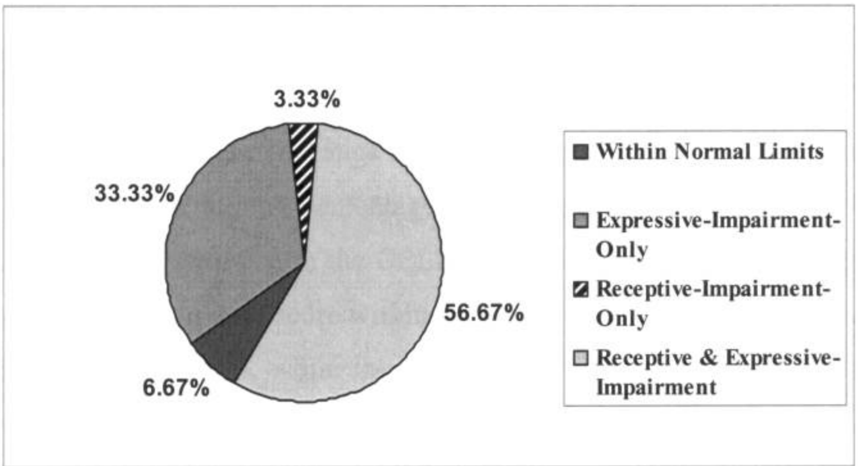


Figure 4-15. Individual Profiles of Impairment within HFA-T1 Group

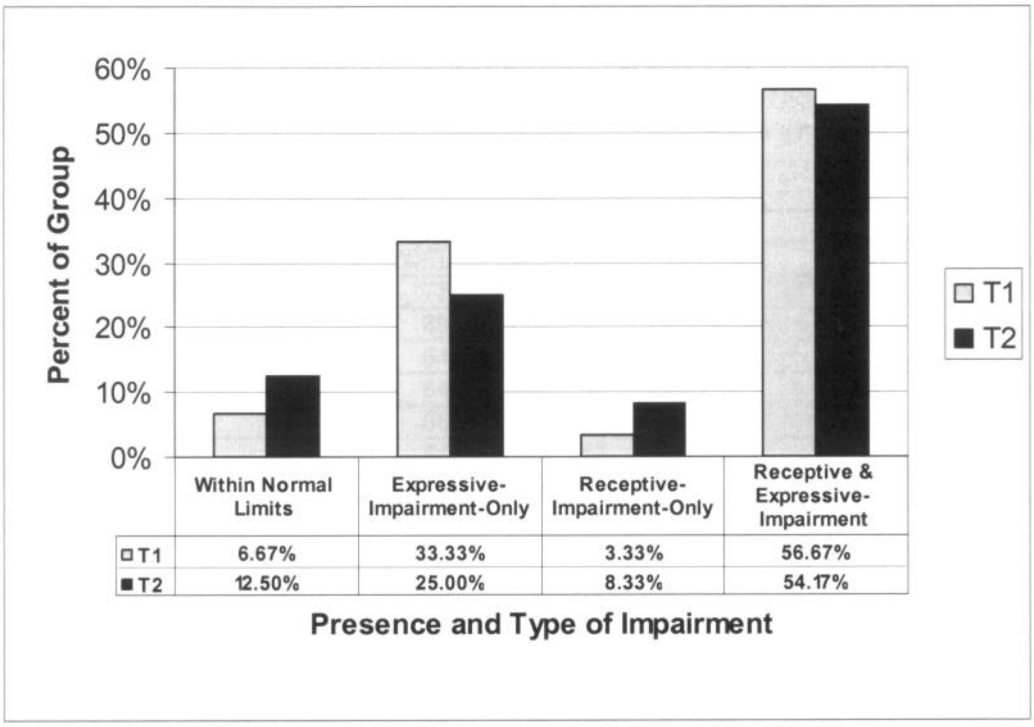


Figure 4-16. Change of Individual Presence and Type of Language Impairment across Time Points

Table 4-36 shows details of standard scores which were below 77.5 and therefore within the impairment range at T1 on the individual assessment measures. At both T1 and T2, the highest percentage of children scoring in the impaired range on any single measure occurs on the CELF-3 (T1-89.66%, T2-78.26%). A slightly higher percentage of children score within the impaired range at T1 (51.61%) than at T2 (45.83%) on the BPVS, while the opposite is true with the TROG; a slightly higher percentage of T2 children (50%) show impairment than did at T1 (48.39%).

Table 4-36. Scores Indicating Impairment across Each Measure by Participants at T1; shaded areas indicate score above 77.5 (thus within normal limits). X indicates assessment not completed (BPVS=British Picture Vocabulary Scales; EOWPVT-R=Expressive One-Word Picture Vocabulary Test-Revised; CELF-3=Clinical Evaluations of Language Fundamentals-3 UK; GF=Goldman-Fristoe Test of Articulation; TROG=Test for Reception of Grammar; RPM=Raven's Progressive Matrices; WNL=Within normal limits)

		HFA - T1			
ID	BPVS	CELF	TROG	GF	RPM
01 HFA		77			
02 HFA		69	75		
3	76	64	63		75
04 HFA	65	64	63		
05 HFA	66	65	62		
06 HFA	33	65	57		
07 HFA	75	71		61	
08 HFA	58	65	66		75
09 HFA		64			75
10 HFA				74	
11	77	69			X
12 HFA	76	66	62		
13	59	64	76		
14 HFA		73			
15 HFA					
16 HFA	58	64	55		
17 HFA	63	64	63	40	
18 HFA	72	64	76		
19 HFA		77		40	
20 HFA	63	X	60		
21 HFA	76	65	70		
22 HFA		69			
23 HFA		69			
24 HFA	76	64	76		
25		66	70		
26		X			75
27 HFA		75			
28		72			
29	74				
30 HFA		77			
31 HFA		71			
Impaired	16 (51.61%)	26 (89.66%)	15 (48.39%)	4 (12.90%)	4 (13.33%)
WNL	15 (48.39%)	3 (10.34%)	16 (51.61%)	27 (87.10%)	26 (86.67%)
Total N	31	29	31	31	30

Children whose profiles change from no impairment to any impairment or from a receptive-only or expressive-only impairment to a combined impairment are described as showing a decline in skill (and vice versa for improvement). Moving from a single impairment type to another single impairment type is described as a change. The majority of children (75%) show no change in presence or type of language impairment over time, three children (12.5%) show improvement, two children (8.33%) show decline and one child (4.14%) changes from an expressive-impairment-only to a receptive-impairment-only. Table 4-37 shows these changes over time by each participant.

Table 4-37. Change of Presence and Type of Language Impairment within Participants over Time; shaded cells indicate a change in status, black cells denote individuals who did not participate at T2

ID	T1	T2	Over Time
01 HFA	Exp	WNL	Improve
02 HFA	Rec & Exp	Rec & Exp	
03 HFA	Rec & Exp		
04 HFA	Rec & Exp	Rec & Exp	
05 HFA	Rec & Exp	Rec & Exp	
06 HFA	Rec & Exp	Rec & Exp	
07 HFA	Rec & Exp	Rec & Exp	
08 HFA	Rec & Exp	Rec & Exp	
09 HFA	Exp	Exp	
10 HFA	WNL	WNL	
11 HFA	Rec & Exp		
12 HFA	Rec & Exp	Rec & Exp	
13 HFA	Rec & Exp		
14 HFA	Exp	Exp	
15 HFA	WNL	Rec	Decline
16 HFA	Rec & Exp	Rec & Exp	
17 HFA	Rec & Exp	Rec & Exp	
18 HFA	Rec & Exp	Rec & Exp	
19 HFA	Exp	Exp	
20 HFA	Rec & Exp	Rec & Exp	
21 HFA	Rec & Exp	Exp	Improve
22 HFA	Exp	Exp	
23 HFA	Exp	Rec & Exp	Decline
24 HFA	Rec & Exp	Rec & Exp	
25 HFA	Rec & Exp		
26 HFA	X		
27 HFA	Exp	WNL	Improve
28 HFA	Exp		
29 HFA	Rec		
30 HFA	Exp	Rec	Change
31 HFA	Exp	Exp	

4.3.2 Prosody

4.3.2.1 Total and Subtest Scores -Group

Significant gains are revealed in both the PEPS-C total score (z = -3.462, $p < .001$, effect size .50) and the Percent correct score over time (z = -3.463, $p < .001$, effect size .50). Significant gains are also revealed in both the PEPS combined input subtests score (z = -3.353, $p < .001$, effect size .46) and the combined output subtests score over time (z = -2.700, p = .005, effect size .38). Within individual subtests on the PEPS-C, significant gains are noted in the Affect Input subtest score (z = -3.199, p = .001, effect size .44) and the Intonation input subtest score over time (z = -2.861, p = .002, effect size .40). Trends toward significance are apparent in the Affect output subtest (z = -2.328, p = .018, effect size .33) and the Focus Output task (z = -2.330, p = .018, effect size .33). Figure 4-17 illustrates the changes over time on the PEPS-C subtests. Table 4-38 compares PEPS-C scores at T1 and T2. Scores ≥12 indicate competency level on an individual subtest has been reached. At T1, competency was not met or exceeded on any subtest, while at T2 competency is met or exceeded on 7 of 12 (58.33%) subtests; therefore substantial gains have been made on prosodic skills as assessed by the PEPS-C. At T1, ceiling effects were present in 10/12 subtests and at T2, they are present in 11/12 subtests.

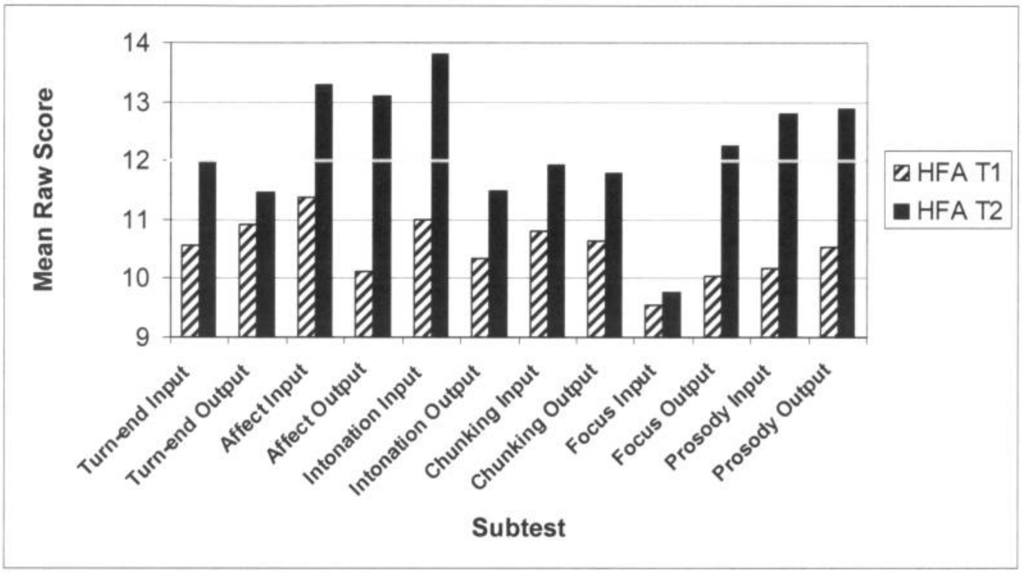


Figure 4-17. Comparison of Profiling Elements of Prosodic Systems –Children (PEPS-C) Mean Raw Subtest Scores at T1 and T2; scores within and above the yellow bar (≥12) indicate competency level (75% correct) has been reached. The highest possible raw score for each subtest is 16.

Table 4-38. Comparison of HFA-T1 and HFA-T2 Mean Group Scores and Standard Deviations on Profiling Elements of Prosodic Systems-Children (PEPS-C); significant improvement at T2 is detailed in the right hand column with values ≤05 in lightly shaded cells; values ≤01 in darkly shaded cells; blank cells indicate no significant differences found

HFA	T1				T2				
	N	Mean	Max	SD	N	Mean	Max	SD	Difference
VARIABLE									Sig Level
T-End Input	31	10.55	16	3.42	21	12.00	16	4.02	
T-End Output	30	10.9	16	2.94	20	11.45	16	3.53	
Affect Input	31	11.39	16	3.46	21	13.24	16	2.95	p =.001
Affect Output	30	10.13	16	3.86	19	13.11	16	2.60	p =.018
Chunking Input	31	10.81	15	2.51	21	11.90	16	2.47	
Chunking Output	30	10.63	16	2.74	20	11.80	16	2.33	
Focus Input	30	9.53	16	2.56	21	9.76	16	3.02	
Focus Output	29	10.03	16	3.57	20	12.25	16	2.67	p =.018
Intonation Input	31	11	16	3.52	21	13.81	16	2.99	p =.002
Intonation Output	30	10.35	15	3.86	20	11.50	15.5	4.01	
Prosody Input	31	10.16	16	3.70	21	12.81	16	3.63	
Prosody Output	30	10.52	16	3.03	20	12.88	16	2.87	
Input Subtests	30	63.77	90	14	21	73.52	96	12.80	p <.001
Output Subtests	29	62.79	87	12.80	19	73.16	94.5	12.61	p =.005
Percent Correct	29	65.72	91.15	12.32	19	76.44	99.22	12.27	p <.001
Peps Total	29	126.17	175	23.64	19	146.84	190.5	23.65	p <.001

4.3.2.2 Comparison of Receptive and Expressive Abilities at T1 versus T2

At T1, mean group receptive (input) abilities were higher than expressive (output) abilities on three of the subtests (Affect, Chunking, Intonation) and mean group expressive abilities were higher on the other three subtests (Turn-End, Focus, Prosody), as is shown in Table 4-40. Wilcoxon signed ranks test with T1 data reveals no significant differences between receptive and expressive skill either on any one individual subtest, or between the combined receptive and the combined expressive subtests. However, at T2, significant differences emerge between receptive and expressive ability on the Intonation (receptive scores higher) and Focus subtests (expressive scores higher).

4.3.2.3 Prosody and Language at T1 versus T2

Statistical analyses at T1 were mainly parametric measures and such is not the case at T2; while this makes direct comparison problematic, similar profiles could still realistically be expected. At T1 significant relationships ($p < .01$) were apparent between the combined PEPS-C Input scores with grammar, non-verbal cognition and chronological age (McCann et al., in press), however at T2 only a single input task (Turn-end) correlates with grammar, whilst no correlations exist between receptive prosody and either non-verbal cognition or chronological age. Additionally, at T1 significant correlations were noted between the total PEPS-C score and receptive vocabulary, grammar and expressive language, whilst at T2 the correlation with vocabulary and expressive language continues but that with grammar no longer exists. Similarly, the T1 correlation between grammar and the combined PEPS-C output tasks no longer exists at T2, although those between the output tasks, vocabulary and expressive language remain.

4.3.2.4 Subjective Judgments of Expressive Prosody

At T1, the examiner who gathered the data made subjective judgments regarding presence or absence of AEP in all of the 31 children (J. McCann, personal communication, October 12, 2005) noting its overall occurrence in 64.5% of participants (15 of 24 boys (62.5%) and 5 of 7 girls (71.43%)). As noted earlier, the inter-rater agreement for the judgment of typical versus atypical expressive prosody in the HFA-T2 children is 100%.

4.3.2.5 Performance on Language Assessments T1 and T2 - AEP versus No-AEP

Comparison of the AEP vs. No-AEP groups' mean PEPS-C scores at T1 is undertaken using the Kruskal Wallis test which reveals no significant difference between groups on any of the language or non-verbal cognition standard scores (BPVS, TROG, CELF-3, GF, RPM), although the No-AEP group outranks the AEP group on all measures.

A similar comparison at T2 (now also comparing the expressive vocabulary scores as well, which were not assessed at T1) shows a significant difference between AEP and No-AEP on the BPVS (H (1) 5.836, p=.013) and the CELF-3 (H (1) 7.340, p = .005). Follow-up Kolmogorov-Smirnov tests, using a $\leq .017$ significance level after the Bonferroni correction, reveal the No-AEP significantly outperforms the AEP group on the CELF-3 (Z = 1.449, p = .011, r = .32).

4.3.2.6 Performance on PEPS-C at T1 and T2 – AEP versus No-AEP

A comparison of the AEP vs. No-AEP groups' mean PEPS-C scores at T1 is undertaken using the Kruskal Wallis test which reveals a significant difference between groups on the Intonation input subtest (H (1) 4.943, p=.025), Chunking input subtest (H (1) 3.843, p = .05) and the Peps total score (H (1) 3.824, p = .051). Follow-up Kolmogorov-Smirnov tests using a $\leq .01$ significance level after the Bonferroni correction reveal the No-AEP group just misses reaching significance in outperforming the AEP group on the total PEPS-C score (Z = 1.497, p = .015, r = .29).

At T2, the No-AEP group significantly outperforms the AEP group on the PEPS-C total score as well as on the Chunking output and Affect output tasks (see section 4.2.2.11, page 144). Therefore at both time points, the No-AEP group continues to achieve better overall scores than the AEP group on the total prosody assessment score. However at T2, the gap in some discrete prosodic skills has widened between those with and without AEP, particularly with the expression of phrase boundaries to differentiate prosodic meaning to indicate two items or three items (Chunking output) and using prosody to indicate liking versus disliking (Affect task).

4.3.3 Summary of HFA at T1 and T2

This section has presented a comparison of the HFA groups at T1 and T2 on measures of language and prosody.

4.3.3.1 Language

The main language findings from T1 to T2 include:

- On most measures, raw language scores show significant improvement over time and standardised scores remain fairly stable. Thus, whilst the HFA-T2 group is not closing the gap with TD children, they are showing improvement in skills and are developing language along a similar but delayed trajectory;
- At both T1 and T2, expressive language ability continues to be the most impaired skill, whilst single-word articulation and non-verbal cognition are relative strengths;
- A combined receptive-and-expressive impairment continues to be the most prevalent type of profile in the individual participants at both T1 and T2;
- Fewer children show an expressive-impairment-only over time, slightly more show a receptive-only-impairment;
- At T2, three children show no language impairment, a slight improvement from the two children who did so at T1;
- The Children's Communication Checklist (CCC-2) appears to be a better tool for identifying pragmatic impairment than the original version (CCC); the HFA-T2 group show a pragmatic skill deficit profile that is more consistent with their diagnosis.

4.3.3.2 Prosody

Assessment of prosodic ability in structured tasks reveals:

- At T2, significant group gains are made on the PEPS-C Total score, the receptive (Input) subtests and expressive (Output) subtests and competency levels are achieved on 58.33% of PEPS-C subtests, whilst at T1, competency was not attained on any subtests;
- No change is apparent in the expressive prosodic ability noted in spontaneous speech, as all participants who were judged to have AEP at T1 continue to evidence it at T2, with 100% inter-rater agreement in subjective judgments;
- At T2, the group of children with typical expressive prosody (No-AEP) significantly outperforms the group with atypical expressive prosody (AEP) on expressive language, yet this difference was not apparent at T1;
- At both time points, the No-AEP group outperforms the AEP group on the total PEPS-C score but this difference only reaches significance at T2, indicating the gap in structured prosodic ability between those with and without AEP had widened over time.

4.4 HFA: SIMILARITIES & DIFFERENCES WITH TD

4.4.1 Overview

4.4.1.1 Participants

As described in the Methodology chapter, a control group of TD children at Time point 2 (TD-T2) was assembled by matching each HFA-T2 participant by sex and T2 verbal mental age (using the BPVS age equivalent score) to one of the 72 TD children tested during the 2004 "Prosodic Ability in Children with Autism" study (Gibbon et al., 2004; Peppé et al., in press; McCann et al., in press). The TD-T2 group's mean chronological age was 7.47 and ranged from 4.83 to 14.67 years.

4.4.2 Language Assessments

4.4.2.1 BPVS Age Equivalent Scores

The BPVS age equivalent scores of the TD-T2 participants range from 5.08 to 15.67 years (*M* 8.16, *SD* 2.77). Contrary to the HFA-T2 group, the TD-T2 BPVS age equivalent scores are significantly higher than their chronological age (Wilcoxon signed ranks, $z = -2.587$, $p = .008$, effect size .53) with a much sharper upward trend and much more homogeneity of scores than the HFA group, as is shown in Figure 4-18. As the HFA-T2 and TD-T2 are matched on BPVS age equivalent scores, it is reassuring that no significant difference exists between groups (Kolmogorov-Smirnov test, $Z = -.239$, $p = 1.00$). As was found at T1 (McCann et al., in press), the HFA-T2 continues to be significantly older than the TD group ($Z = 2.742$, $p < .001$, $r = .40$).

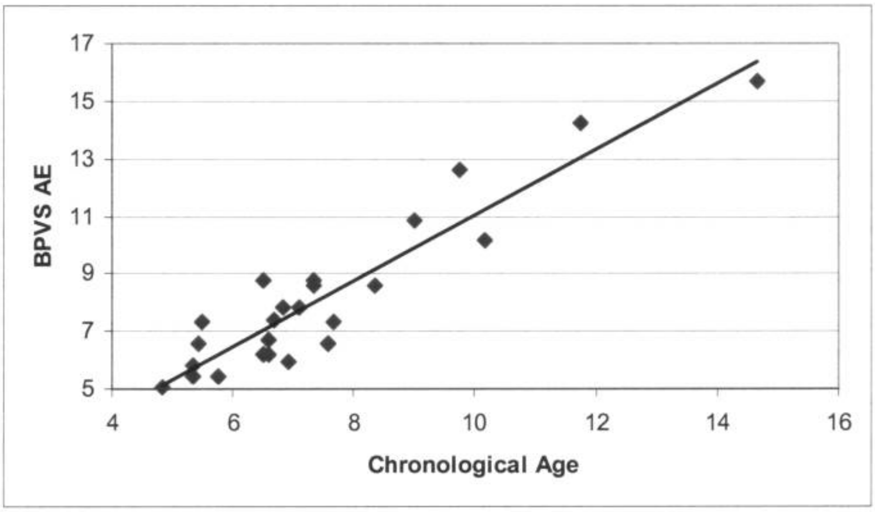


Figure 4-18: Comparison of Chronological Age with British Picture Vocabulary Scale (BPVS) Age Equivalent (AE) Scores for TD-T2

4.4.2.2 BPVS Standard Scores

BPVS standard scores for the TD-T2 group range from 92 to 121 (*M* 105.96, *SD* 8.51). As is apparent in Table 4-39, all scores fall within the average to above-average range. Although both HFA-T2 and TD-T2 have BPVS scores that are normally distributed (Shapiro-Wilk, $p = .812$ and .407, respectively) they violate

Levene's test for equality of variances (F (46, 30.86) = 14.661, p <.001) so a non-parametric comparison is undertaken. A Kolmogorov-Smirnov test reveals the TD-T2 group significantly outperforms the HFA-T2 group on the BPVS standard score (Z = -4.942, p < .001, effect size -.71); this concurs with the finding at T1 (McCann et al., in press).

Table 4-39: Distribution of TD-T2 BPVS Standard Scores; all are within or above the average range

N	% of Total	Distribution	Score
3	12.5	+ 1SD	> 115
21	87.5	Average	85 - 114

4.4.3 Prosody

4.4.3.1 PEPS-C Total and Subtest Scores – TD-T2

Table 4-40 details the means, standard deviations, score ranges and number of participants for the TD-T2 group's PEPS-C individual subtest scores with scores above 12 indicating competency has been achieved (Peppé & McCann, 2003). The TD group meets or surpasses competency on 9 out of 12 (75%) subtests. Ceiling effects are present in every individual subtest. The group scores for Turn-end input, Chunking output and Focus input subtests are below competency level. Figure 4-19 illustrates the subtest scores for the TD group.

4.4.3.2 Comparison of Receptive and Expressive Abilities – TD-T2

At T2, Wilcoxon signed ranks tests reveal the TD group to have significantly higher scores on the receptive Affect subtest (as compared to the expressive score) (p = .026, Z = -2.226, r = .49) and significantly higher scores on the expressive Focus and Prosody subtests (p = .001, Z = -3.217, r = .72; p = .029, Z = -2.184, r = .48, respectively) than on the same receptive subtests. The combined receptive subtests outrank the combined expressive subtests, however the difference is not significant (p = .412, Z = -.846).

Table 4-40: Means, SD and Score Ranges on Profiling Elements of Prosodic Systems-Children (PEPS-C) by TD-T2; mean scores are indicated by shading in the cells

	TD-T2				
	N	Min	Max	Mean	SD
Turn-End Input	21	5	16	11.29	3.45
Turn-End Output	20	8	16	12.40	2.66
Affect Input	21	10	16	14.14	1.96
Affect Output	19	8	16	12.89	2.69
Chunking Input	21	6	16	12.00	2.95
Chunking Output	20	8	16	11.50	2.67
Focus Input	21	8	16	11.33	3.04
Focus Output	20	10	16	14.00	1.89
Intonation Input	21	8	16	13.52	2.58
Intonation Output	20	6	16	12.80	2.92
Prosody Input	21	7	16	12.67	2.82
Prosody Output	20	10.5	16	14.28	1.59
Input Subtests	21	52	93	74.95	12.53
Output Subtests	19	55.5	95	78.05	9.26
Percent Correct	19	56.51	97.92	80.24	10.94
PEPS-C Total	19	108.5	188	154.05	21.01

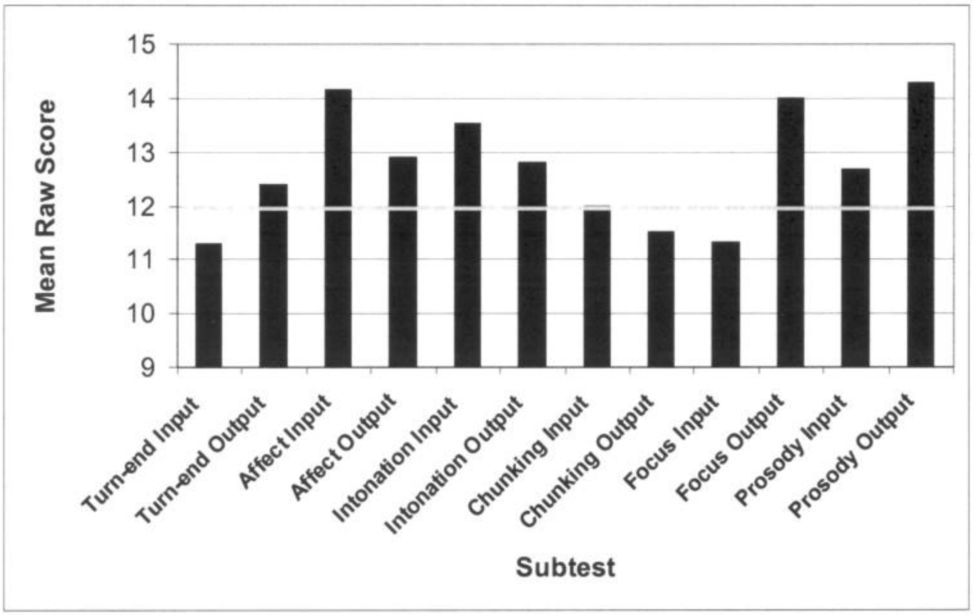


Figure 4-19 TD-T2 Group Profiling Elements of Prosodic Systems –Children (PEPS-C) Mean Raw Subtest Scores; scores within and above the yellow bar (≥12) indicate competency level (75% correct) has been reached. The highest possible raw score for each subtest is 16

4.4.3.3 PEPS-C Total and Subtest Scores – TD-T2 and HFA-T2

Table 4-41 compares the means, standard deviations and score ranges of the TD-T2 group to those of the HFA-T2 group. Figure 4-20 compares the TD-T2 and HFA-T2 scores on PEPS-C subtests. Whilst the TD-T2 achieves competence on 75% of subtests, the HFA-T2 achieves competence on 58.33%. Both groups are below competency level on the Chunking output and Focus input subtests; however the HFA-T2 group reaches competency on the Turn-end input subtest while the TD-T2 group does not. On the other hand, the HFA-T2 does not match the TD group in reaching competence level on either the Chunking input or Intonation input subtest.

Comparison of the TD-T2 with the HFA-T2 groups on all the PEPS-C subtests and total score using the Kruskal Wallis tests reveals significant differences between groups only on the Focus input (H (1) 3.969, p = .047) and Focus output subtests (H (1) 4.668, p = .03), with the TD group showing a higher ranking on both subtests. Follow-up Kolmogorov-Smirnov tests using ≤ .025 significance levels after the Bonferroni correction reveal no significant differences, however. (Focus output $Z = .949$, $p = .214$; Focus input $Z = 1.080$, $p = .092$).

Table 4-41: Comparison of Means, SD and Score Ranges on Profiling Elements of Prosodic Systems-Children (PEPS-C) by TD-T2 & HFA-T2; the HFA-T2 data are in the shaded cells

	TD-T2					HFA-T2			
Test	N	Min	Max	Mean	SD	Min	Max	Mean	SD
Turn-End Input	21	5	16	11.29	3.45	3	16	12.00	4.02
Turn-End Output	20	8	16	12.40	2.66	7	16	11.45	3.53
Affect Input	21	10	16	14.14	1.96	6	16	13.24	2.95
Affect Output	19	8	16	12.89	2.69	6	16	13.11	2.60
Chunking Input	21	6	16	12.00	2.95	8	16	11.90	2.47
Chunking Output	20	8	16	11.50	2.67	8	16	11.80	2.33
Focus Input	21	8	16	11.33	3.04	7	16	9.76	3.02
Focus Output	20	10	16	14.00	1.89	6	16	12.25	2.67
Intonation Input	21	8	16	13.52	2.58	5	16	13.81	2.99
Intonation Output	20	6	16	12.80	2.92	4.5	15.5	11.50	4.01
Prosody Input	21	7	16	12.67	2.82	5	16	12.81	3.63
Prosody Output	20	10.5	16	14.28	1.59	6	16	12.88	2.87
Input Subtests	21	52	93	74.95	12.53	49	96	73.52	12.80
Output Subtests	19	55.5	95	78.05	9.26	43.5	94.5	73.16	12.61
Percent Correct	19	56.51	97.92	80.24	10.94	53.91	99.22	76.44	12.27
Peps Total	19	108.5	188	154.05	21.01	103.5	190.5	146.84	23.65

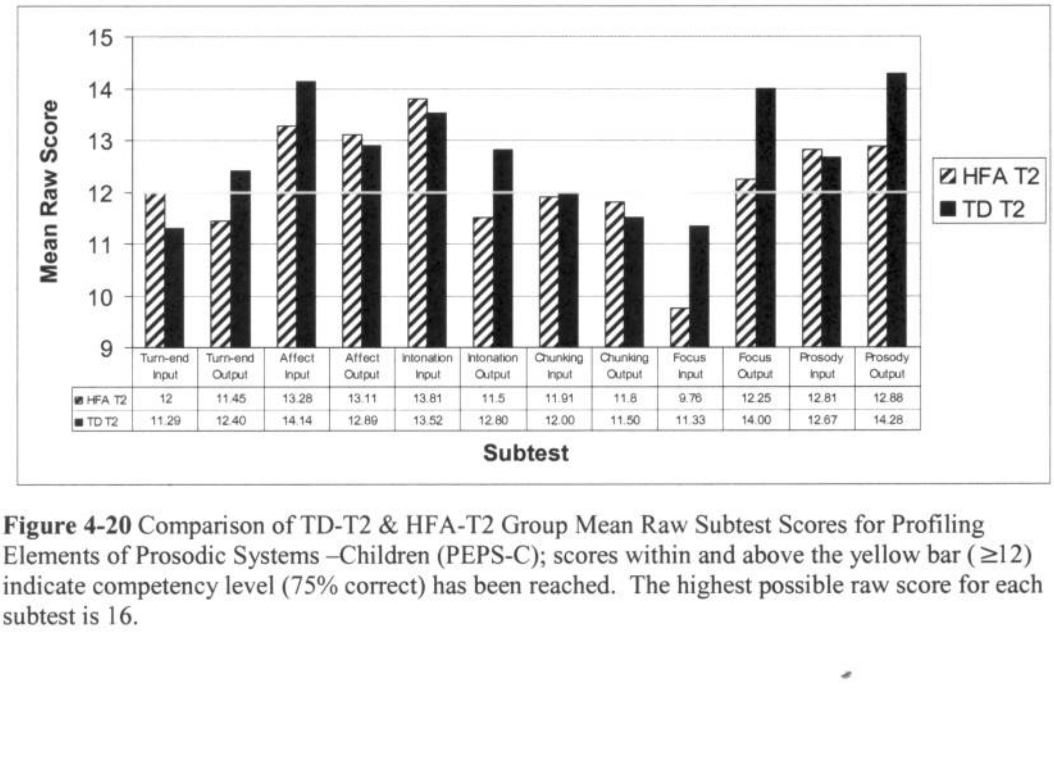


Figure 4-20 Comparison of TD-T2 & HFA-T2 Group Mean Raw Subtest Scores for Profiling Elements of Prosodic Systems –Children (PEPS-C); scores within and above the yellow bar (≥12) indicate competency level (75% correct) has been reached. The highest possible raw score for each subtest is 16.

4.4.3.4 PEPS-C Total and Subtest Scores – Comparison of Groups at T1 and T2

At T1, children with HFA were noted to perform significantly less well ($p = < .001$) on the PEPS-C total score than the TD verbal age-matched group (McCann et al., in press). However, at T2, the children with HFA no longer show a significant difference between the total or individual subtest scores as compared to the children with TD, although at T2 the children with HFA were matched by verbal mental age with a different group of children with TD than at T1.

4.4.3.5 Correlations between Prosody and Language

Table 4-42 presents correlations found between BPVS and PEPS-C scores as well as chronological age and PEPS-C scores for both the TD and HFA groups at T2. Chronological age shows no correlation with prosodic ability in the HFA-T2 group, while the majority of the PEPS-C scores do correlate with chronological age in the TD group.

Table 4-42: Comparison of Correlations Found Within HFA-T2 and TD-T2 Groups between Profiling Elements of Prosodic Systems-Children (PEPS-C),British Picture Vocabulary Scale raw scores (BPVS-rs) and Chronological Age (CA); lightly shaded areas indicate significance at ≤.05 level and darkly shaded areas indicate significance at ≤.01 level, blank cells indicate no significance found using Spearman's rho, 2-tailed

HFA-T2		BPVS-rs	CA	TD-T2		BPVS-rs	CA
Turn-End Input	corr co	.483 *	ns	Turn-End Input	corr co	.644 **	.603 **
	sig	.026			sig	.002	.004
	n	21			n	21	21
Turn-End Output	corr co	.470 *	ns	Turn-End Output	corr co	.478 *	.540 *
	sig	.036			sig	.033	.014
	n	20			n	20	20
Affect Input	corr co	.613 **	ns	Affect Input	corr co	.496 *	.440 *
	sig	.003			sig	.022	.046
	n	21			n	21	21
Affect Output	corr co	.725 **	ns	Affect Output	corr co	ns	ns
	sig	.000			sig		
	n	19			n		
Intonation Input	corr co	ns	ns	Intonation Input	corr co	.718 **	.596 **
	sig				sig	.000	.004
	n				n	21	21
Intonation Output	corr co	ns	ns	Intonation Output	corr co	ns	ns
	sig				sig		
	n				n		
Chunking Input	corr co	ns	ns	Chunking Input	corr co	.552 **	.649 **
	sig				sig	.010	.001
	n				n	21	21
Chunking Output	corr co	.477 *	ns	Chunking Output	corr co	ns	ns
	sig	.033			sig		
	n	20			n		
Focus Input	corr co	ns	ns	Focus Input	corr co	.629 **	.604 **
	sig				sig	.002	.004
	n				n	21	21
Focus Output	corr co	.511 *	ns	Focus Output	corr co	ns	ns
	sig	.021			sig		
	n	20			n		
Prosody Input	corr co	.473 *	ns	Prosody Input	corr co	.595 **	.539 *
	sig	.030			sig	.004	.012
	n	21			n	21	21
Prosody Output	corr co	ns	ns	Prosody Output	corr co	.697 **	.707 **
	sig				sig	.001	< .001
	n				n	0	20
PEPS-C Total	corr co	.741 **	ns	PEPS-C Total	corr co	.790 **	.744 **
	sig	< .001			sig	< .001	< .001
	n	19			n	19	19
Input Subtests	corr co	.587 **	ns	Input Subtests	corr co	.840 **	.800 **
	sig	.005			sig	< .001	< .001
	n	21			n	21	21
Output Subtests	corr co	.639 **	ns	Output Subtests	corr co	.659 **	.651 **
	sig	.003			sig	.002	.003
	n	19			n	19	19

4.4.4 Summary of TD and HFA at T2

This section has presented a comparison of the receptive vocabulary and prosody skills of the group of children with HFA and those with typical development (TD) at T2.

4.4.4.1 Receptive Vocabulary

The main findings of the receptive vocabulary skills are:

- Although matched on verbal mental age (as assessed by a measure of receptive vocabulary), the TD group significantly outperform the HFA group on receptive vocabulary standard scores.

4.4.4.2 Prosody

The main findings of the prosody skills as assessed by the PEPS-C are:

- There is no longer a significant difference in PEPS-C Total, receptive (Input) subtests or expressive (output) subtest between the HFA and TD groups;
- The TD group meets or exceeds competency levels on 75% of subtests whilst the HFA group meets or exceeds competency levels on 58.33% of subtests;
- Both the TD and the HFA groups remain below the competency level on the Chunking Output and Focus Input tasks;
- The TD group significantly outperforms the HFA group on both the Focus Input and Focus Output subtests in a preliminary analysis comparing results of all the PEPS-C scores; however these differences are not upheld with post-hoc tests.

4.5 SUMMARY

This chapter has presented the results of this investigation of language, prosody and ToM skills in children with HFA. Additionally, a comparison of the language and prosody skills was undertaken with the group of children with HFA at the first Time point. Further investigation was undertaken with the HFA group at Time point 2, comparing the results of receptive vocabulary and prosody skills with verbal-aged matched typically developing children. In the following chapter, a detailed discussion of these findings will be presented.

5

Discussion

The discussion of research findings will begin with an examination of the outcomes of the hypotheses made for this study, followed by a comparison of results from the current study to findings reported in the research literature. The longitudinal data and T2 data will be discussed at varying intervals throughout the chapter, depending on the context, which is a different structure than the previous chapters. Theoretical implications of language skills, prosodic ability and ToM, separately and in combination, will be asserted. Next, discussions about delayed versus deviant abilities and possible overlapping diagnostic boundaries between HFA and specific language impairment, as well as between HFA and Asperger syndrome will be presented. Implications for assessment and intervention as a result of the findings from the current study will then be delineated. Finally, an evaluation of the methodology used in this study will be presented, followed by suggestions for future directions in research.

5.1 RESULTS OF HYPOTHESES

5.1.1 Hypothesis One

This hypothesis stated that the HFA-T2 group's language and communication skills, as measured by standardised scores, would continue to be well below those of their typical peers. Across language measures there were no significant increases in standardised scores over time, thus upholding this hypothesis. Importantly, however, the group did not show a significant decline in standardised scores. Moreover, there were significant gains in raw scores on all language measures (except for receptive grammar where different test versions precluded this type of comparison). These findings support those reported by Tager-Flusberg et al. (1990), indicating that school-aged children with HFA continue to acquire language skills along a similar trajectory to those with typical development, but at a delayed pace; thus the gap between groups remains over time.

The current study has found evidence that supports Kjelgaard and Tager-Flusberg's (2001) claim that "deficits in language skills are not universal in autism, although they are found in the majority of children with this disorder" (p. 302). At both time points, more than 85% of the children with HFA presented with impaired ability in at least one aspect of language. Further, more than 50% presented with combined impairments on both receptive and expressive language measures. These results are not unexpected, given that children with HFA have had language impairments evident in their preschool years and impaired language skills are a defining characteristic of those with HFA (World Health Organization, 1992; American Psychiatric Association, 1994). It is nonetheless important given the paucity of both longitudinal language research (Tager-Flusberg et al., 2005) and studies involving sample sizes of children with HFA that are greater than 20, which are rare (Peterson et al., 2005).

5.1.2 Hypothesis Two

Due to the significant difference in group performance between the children with HFA and those with typical development on the structured prosody assessment (PEPS-C) at T1, as well as the finding that many response patterns were deviant as compared to children with typical development (Peppé et al., in press), it was hypothesised that prosodic skills over time would continue to be impoverished as compared to language-age matched peers. This hypothesis was not upheld; the HFA group did show significantly improved abilities on the PEPS-C as a whole, such that the statistical gap between children with HFA and those with typical development was no longer evident at T2. However, the group of children with HFA achieved lower scores than the typically developing children on 7/12 subtests. The largest discrepancy was seen on the receptive and expressive contrastive stress tasks which approached, but did not meet, significance. These are important and noteworthy findings as they represent the first longitudinal quantitative data on prosodic ability in children with HFA.

The HFA group's verbal-mental age also improved significantly and probably accounts, at least in part, for the growth evidenced in prosodic abilities. However, the significant improvement seen on the PEPS-C assessment highlights a discrepancy between abilities in structured tasks and those seen in spontaneous speech, as all the children who were judged to have atypical expressive prosody (AEP) at T1 continued to be judged the same at T2.

5.1.3 Hypothesis Three

The third hypothesis predicted that the children with HFA who showed the poorest performance on the prosody assessment would also have the lowest scores for the ToM tasks. This hypothesis was upheld, as evidenced by the strong upward trend in PEPS-C scores which occurred as the score increased on the ToM aggregate. Additionally, those children without AEP in their spontaneous speech significantly outperformed those with AEP on the ToM aggregate score. Although language was shown to be highly correlated with the ToM measures, the PEPS-C assessment, and the subjective judgment of presence or absence of AEP, the partial correlation analysis established that a relationship exists between prosody and ToM which is independent of language. This represents a notable finding, as it is the first direct evidence of this relationship, lending significant support to the claim by Rutherford et al. (2002) that at least some aspects of prosody are an auditory expression of ToM. These findings also concur with those by McCann and Carroll et al. (2006), which reported that ToM ability showed a significant positive correlation with prosody scores on the PEPS-C assessment in children with Asperger syndrome, although in their preliminary analyses, the authors did not control for the effects of language.

5.2 Comparison of Results to Research Literature

5.2.1 Language

5.2.1.1 Group Findings

As a group, the children with HFA demonstrated impairment in receptive and expressive vocabulary ability, supporting previous findings (Venter et al., 1992; Kjelgaard & Tager-Flusberg, 2001). Over time, the HFA group's standard score for receptive vocabulary skills did not change significantly, while the increase noted in raw scores indicates that the children are continuing to increase their lexicons. Additionally, the lack of significant differences between receptive and expressive vocabulary abilities in this HFA group further supports previously reported results (Kjelgaard & Tager-Flusberg, 2001).

Results from this study also support previous findings which have established that children with HFA have significant difficulty with expressive language skills (Kjelgaard & Tager-Flusberg, 2001; Landa & Goldberg, 2005; Lloyd et al., 2006; McCann et al., in press) and show a delayed but developmental progression of receptive grammatical abilities (Tager-Flusberg, 1981; Paul & Cohen, 1984). No significant differences were revealed between vocabulary and grammatical abilities, again replicating previous findings (Jarrold et al., 1997; Kjelgaard & Tager-Flusberg, 2001) as well as those reported with the HFA group at T1 (McCann et al., in press). Single-word articulation skills represented the least impaired area of language, supporting a similar finding reported by Boucher (2003). However, articulation skills were not universally spared, as has been suggested (Jarrold et al., 1997; Kjelgaard & Tager-Flusberg, 2001).

The HFA-T2 group had non-verbal cognitive skills which remained in the normal range over time. This is congruent with findings reported in the literature (Lord & Schopler, 1989; Lord & Venter, 1992; Eaves & Ho, 1996; Nordin & Gillberg, 1998; Howlin et al., 2004) and reflects the same stability in non-verbal cognitive skills found in children with typical development (Raven et al., 1986; Mackintosh, 1998).

All of the children with HFA at T2 showed impaired pragmatic abilities as evidenced by scores obtained on either the General Communication Composite, the Social Interaction Deviance Composite, or both, from the Children's Communication Checklist – 2nd Edition. This result supports the contention that pragmatic impairments are universal in individuals with ASDs (Kanner, 1943/1985; Twachtman-Cullen, 2000; Volden, 2004; Rice et al., 2005) and is consistent with expectations for children with significant communication challenges such as those with HFA (Bishop, 2003b).

5.2.1.2 Heterogeneity of Individual Skills

As has been found with many previous studies of children with ASDs/HFA (Kanner, 1943/1985; Lord & Schopler, 1989; Lord & Venter, 1992; Venter et al., 1992; Nordin &

Gillberg, 1998; Sigman & Ruskin, 1999; Kjelgaard & Tager-Flusberg, 2001; Dennis et al., 2001; Starr et al., 2003; Lloyd et al., 2006), the children with HFA in this study showed great individual variability in skills across all areas of language, non-verbal cognition and pragmatic skills, as evidenced by a wide range of scores and large standard deviations. Typically developing children tend to have evenly developed abilities (Frith, 1998), whilst the children with HFA showed uneven profiles of strengths and deficits. Analysis of language scores revealed the presence of four differing language skill profiles, with 25% of the HFA-T2 group ($n = 6$) showing a change in their language profile from T1. Therefore, it is reasonable to expect that the profiles evident at T2 similarly may or may not remain stable over time. Any one of these individuals with HFA may show further growth, decline, or plateau of abilities if reassessed at a later point in time, supporting Frith's (1998) contention that individual trajectories are unpredictable. Thus, even within this carefully defined group of children with HFA, children presented with a wide ability range, such that HFA could be described as a spectrum within a [broader ASD] spectrum. The children with language impairments share some resemblance to those with specific language impairment, whilst the children with language skills within normal limits have developed language abilities similar to those children with Asperger syndrome. Although the issue of heterogeneity has at times been obfuscated by debates about diagnostic classification schemes, it continues to have important implications for research and intervention. Professionals and families of children with HFA cannot assume one individual is like another with HFA; in fact, the evidence from this study provides further indication that prognostic advice and intervention methods need to be based on an individual's unique skill and deficit profile, rather than on the diagnostic label. As Volkmar and Klin (2005) aptly stated "It cannot be overemphasized that while the diagnostic label or labels provide helpful information, they do not substitute for a full and rich understanding of the individual's strengths and weaknesses" (p. 10). Figure 5-1 demonstrates the complex and varied score profiles obtained by each individual. The highest score was not always obtained on the measures of articulation or non-verbal cognition (which were the highest scores obtained by the HFA-T2 group); three individuals achieved the highest standardised score on the measure of receptive grammar. Likewise the lowest score was not always noted on the measure of expressive language (which was the lowest group mean score obtained); five individuals scored lowest on the measure of articulation ability and five showed the lowest score on the test of receptive grammar. Additionally, individual scores across all measures showed a maximum spread of 66 points, again demonstrating the clearly unpredictable nature of impairments and abilities within children with HFA. The issue of individual differences will be revisited in the sections discussing implications for intervention and directions for future research.

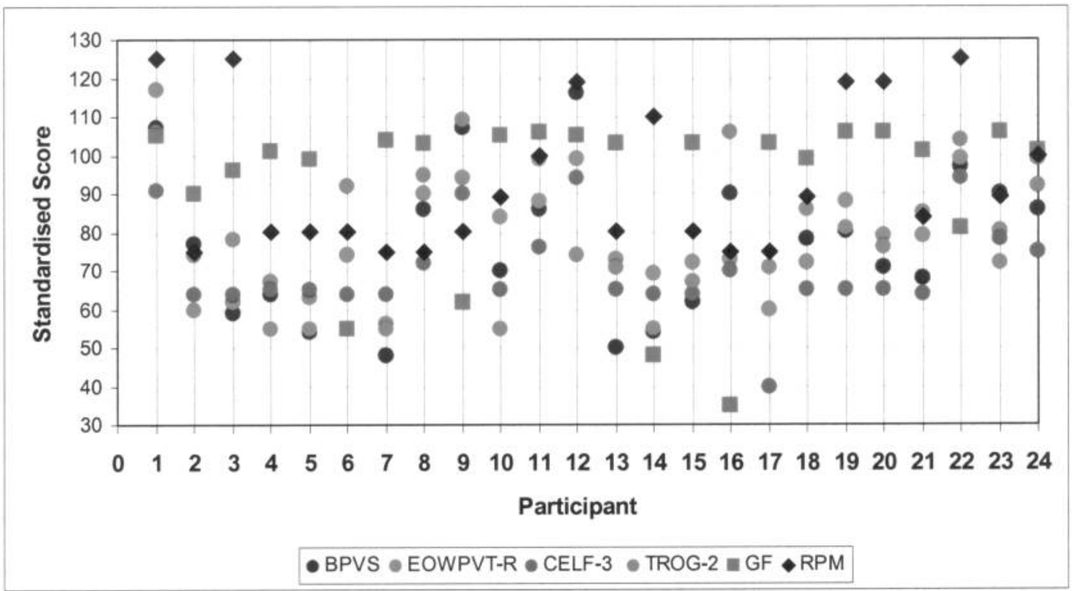


Figure 5-1. Comparison of Standardised Scores for Language and Non-Verbal Cognition across HFA Participants at Time 2 (BPVS=British Picture Vocabulary Scales; EOWPVT-R=Expressive One-Word Picture Vocabulary Test-Revised; CELF-3=Clinical Evaluations of Language Fundamentals-3 UK; GF=Goldman-Fristoe Test of Articulation; TROG-2=Test for Reception of Grammar -2; RPM=Raven's Progressive Matrices)

5.2.2 Prosody

5.2.2.1 Prosodic Ability in Structured Tasks

With no significant differences apparent between the children with HFA and the typically developing children at T2 on the PEPS-C assessment, the results from this study diverge from the majority of those in the literature that have reported difficulty with prosodic abilities such as signalling affect (Rutherford et al., 2002; Peppé et al., in press; Lindner & Rosen, in press), intonational contours (Paccia & Curcio, 1982; Peppé et al., in press), chunking/phrasing, auditory discrimination and imitation of similar or different intonation patterns (Peppé et al., in press). However, findings from the current study indicate that the children with HFA are continuing to have more difficulty on receptive and expressive contrastive stress than typically developing language-age matched peers, thus supporting previous findings (Fine et al., 1991; Shriberg et al., 2001; Paul et al., 2005; Peppé et al., in press), although these differences did not reach significance. Results from this study showed similarity to those by Paul et al. (2005), who found equivocal results between children with HFA and those with typical development on chunking/phrasing, intonational contours and affect; however both studies found ceiling effects on the prosody assessment measures that may have obscured possible differences between groups. An important difference between the current study and the one by Paul et al. (2005) is that the children in this study had previously completed the prosody assessment. Therefore, the gains noted with the HFA group in the current study may have been, at least in part, due to experience with the assessment tool. The issues of possible practice effects and the presence of ceiling effects will be discussed further in the evaluation of study methodology.

Data from this investigation also provided evidence about prosodic skills in typically developing children. The fact that the group of typically developing children at T2 had not reached competency on three subtests of the PEPS-C (Turn-end input, Focus input, Chunking output) by the mean chronological age of 7;05 years (ranging from 4;10 to 14;08 years) provides evidence that several discrete prosodic skills are still not fully developed before adolescence, thus supporting previous findings (Wells et al., 2004; Peppé et al., in press).

5.2.2.2 Prosody and Chronological Age

At T1, there were significant correlations between chronological age and several individual receptive prosody subtests, as well as between chronological age and the combined score from all the receptive subtests (McCann et al., in press). However, at T2 no significant correlations remained between prosodic abilities and chronological age. Perhaps this change is due to the growth in verbal mental-age (as determined by the age equivalent score for receptive vocabulary) over time from a mean of 7 years to 8;03 years. At both time points, the total score on the PEPS-C showed significant correlations with receptive vocabulary, thus the increase in receptive vocabulary may have exceeded a minimum level necessary to understand the receptive prosody tasks.

5.2.2.3 Prosody and Language Ability

Results showed a robust relationship between prosody and language abilities. This relationship seems unsurprising, given that some discrete prosodic features serve grammatical functions, such as questioning versus stating, use of within-word stress to indicate a verb versus a noun, as well as provision of phrase boundaries to segment an utterance into meaningful parts. Pragmatic abilities which are served by some prosodic functions also understandably interact with language, such as the use of contrastive stress to indicate a new or changed piece of information to highlight its importance to the listener. Interestingly, however, prosodic abilities did not show any significant correlation with pragmatic skills.

Existence of a meaningful and early relationship between prosody and language has been asserted in previous work. For example, Gleitman and Wanner (1982) found that typical children rely on stress within words and syllables to begin to develop basic grammatical skills. Chiat (2001) reported that early attention or sensitivity to cues from prosody help the infant to acquire semantic and syntactical knowledge. Jusczyk, Cutler and Redanz (1993) found that 9-month old infants listened longer to strong-weak stress patterns in single words, exactly the patterns which occur most frequently in English; additionally when lexical content was removed via low-pass filtering, the infants showed the same significant preference for the strong-weak stress pattern. Thus, the authors asserted that these infants perceived fine distinctions between English prosodic patterns that occurred more or less frequently. Following up on this evidence, Tager-Flusberg (1985) suggested that early prosodic deficits, particularly the impaired ability to adequately use stress to analyse connected streams of speech into smaller recognisable parts, might predict difficulties in the development of language, at least for some individuals with ASDs.

The results from this study support those reported by McCann et al. (in press) regarding the presence of a significant relationship between language and prosodic abilities in children with HFA, although the exact composition of the relationship has changed over time. Most notably, the relationships that existed between receptive grammatical ability and both receptive and expressive prosodic abilities have become evanescent at T2. It is possible that the change from the original version of the Test for Reception of Grammar to the second version of the test at T2 may have influenced the correlations observed. The original version had easier floor items and this may be evident in the decrease in the group's raw score for grammatical ability over time, whereas raw scores for the other language measures showed increases over time; as the PEPS-C does not provide standardised scores, analyses involving the prosody assessment were undertaken with raw scores. Other correlations seen at T1 between receptive vocabulary, expressive language and the expressive prosodic tasks, as well as the total score on the prosody assessment continued to be evident at T2. No relationship was apparent between articulation and prosody at either T1 or T2; thus supporting previous findings which showed that phonological and prosodic abilities are independent (Wells and Peppé, 2003; McCann et al., in press). Consideration of all of the aforementioned evidence clearly demonstrates that language and prosody are related and the integrity of the relationship between them may be an important factor in later language abilities, however further investigation of the relationship between grammatical and prosodic ability is warranted.

5.2.2.4 Prosody and ToM

Table 1-1 in Chapter 1 (p. 15) presented this author's hypothetical matrix postulating the relationship between prosody and ToM, with reference to language and pragmatics. Each prosodic function (affect, phrase delineation, signalling a question versus a statement, within-word stress, and contrastive stress) was deemed to require sufficient mentalising ability to either understand or be aware of another person's emotional state and/or unique perspective to competently identify or eliminate possible misinterpretations. The finding that prosody correlated with ToM, independent of language ability, suggests that at least to a certain extent, prosody is a phonetic realisation of ToM. Thus, results from the current study support the notion that prosody and ToM ability do interact meaningfully.

5.2.2.5 Atypical Expressive Prosody (AEP)

A higher percentage of children with HFA in this study were judged to have AEP at both T1 and T2 (64.5% and 70%, respectively, with the difference reflecting the number of participants rather than a change in performance) than the 47 - 57% that has previously been reported (Simmons & Baltaxe, 1975; Paul & Shriberg et al., 2005). It is difficult to make assumptions of prevalence based on this small handful of studies and future research will benefit from more such reports, bearing in mind the inherent challenges with subjective judgments. Yet, the 100% agreement in subjective judgments made by independent raters at each time point lends credibility to the finding reported in this study. Additionally, the continued presence of AEP over time, in spite of growth in language abilities, supports the assertions made in previous reports that, when present, odd or atypical expressive prosody persists over time (Kanner 1971/1985; Baltaxe & Simmons, 1985, Rapin & Dunn, 2003). Rutter (1970) wrote:

> "Even among the children who achieved a normal or near-normal level of language competence, abnormalities in ... speech delivery often remained. A monotonous flat delivery with little lability, change of emphasis or emotional expression was characteristic of some children. In others speech was staccato and lacking in cadence and inflection" (p. 440).

Interestingly, this description does not include that of the frequently reported exaggerated or sing-song type of AEP (Simmons & Baltaxe, 1975; McCann & Peppé, 2003; Paul & Sutherland, 2005), which was present in seven children in the current study. The other seven children with AEP in the current study were noted to have flat or monotonous AEP. The finding that children with AEP had difficulties with expressive prosody at opposite extremes concurs with the finding by Baltaxe and Simmons (1985) that children with ASDs had individual fundamental frequency ranges which were either extremely exaggerated or extremely narrow as compared to children with typical development. For the children with HFA in this study, the presence of AEP did not appear to be influenced by positive gains that were made on the assessment of prosody in structured tasks, nor by gains in language skills. However, a higher percentage of the children with receptive-and-expressive-language impairment also had AEP (100%) as compared to those with either a receptive-only-impairment, and expressive-only-impairment or language within the normal range, a fact that highlights the strong relationship between language and prosodic abilities. Additionally, those children with AEP scored lower on the PEPS-C than those without AEP.

Results from the current study indicate that, to some extent, prosodic abilities within structured tasks and those within conversational speech represent different levels of ability. Increased ability on the prosody assessment measure over time may reflect an improvement in meta-prosodic ability, that is, the ability to understand prosodic requirements in highly structured and repetitive sets of tasks, whilst continued presence of AEP in spontaneous conversation indicates that this ability has not transferred to self monitoring of speech. A possible explanation for the difference in prosodic ability within structured tasks as compared to those in spontaneous speech may have to do with the increased demands required for rapid dynamic conversation. This is similar to what Boucher (2003) labelled a 'time-parsing deficit' which suggested that part of the impairment seen in individuals with ASDs is due to a core deficit in the ability to process "transient, sequential stimuli, such as speech" (p. 161). Boucher (2003) argued that all children with ASDs have this impairment, which is particularly evident during conversational exchanges. Wetherby, Prizant and Schuler (2000) speculated that difficulty processing transient stimuli results in specific problems in social interactions and leads to a gestalt processing style which is prevalent in children with ASDs/HFA. Further, they noted that this gestalt processing style is "counter-productive when it comes to unravelling the temporally coded segmental structure of spoken language" (Wetherby et al., 2000, p. 122). Perhaps this time-parsing deficit diminishes the ability of infants with ASDs/HFA to benefit from prosodic cues, in the manner infants and toddlers with typical development do. Likewise, a gestalt processing style may impair the ability to use prosody flexibly in later years, extending to the speech planning process where it may negatively impact expressive prosody skills within spontaneous conversation.

5.2.3 Theory of Mind Results

5.2.3.1 Performance on Wellman and Liu Theory of Mind Scale – Children with HFA versus Typically Developing Children

Results from this study revealed that, as a group, the children with HFA passed the Wellman and Liu (2004) ToM scale tasks in the same developmental pattern as both typically developing American (Wellman and Liu, 2004) and Australian (Peterson et al., 2005) preschool children. The children with HFA in the current study were significantly older, however, with a chronological age approximately seven years greater than the typically developing preschoolers and a mean verbal mental-age approximately four years older than that of the preschool groups. Wellman and Liu (2004) suggested that their ToM scale could provide important information about the developmental progression of children with ASDs, specifically whether or not children with ASDs would pass the individual tasks in the same order as children with typical development. Thus, findings from the current study represent an important finding of delay rather than deviance in the development of the ToM skills assessed with the Wellman and Liu (2004) scale.

5.2.3.2 Comparison with Findings from Peterson, Wellman and Liu

Peterson et al. (2005) also investigated the developmental progression of ToM skills using the Wellman and Liu (2004) scale in 36 children with HFA. However, they reported that the children with HFA followed a different developmental progression from typically developing children and from the HFA children in this study; specifically, their group of children with HFA passed the Hidden Emotion task (the 5th task) with greater accuracy than the Contents False Belief task (the 4th task), thus reversing the order of difficulty of the last two tasks in the scale. What might account for the differences in the performance of children with HFA reported in the Peterson et al. (2005) study and the children with HFA in this investigation? This difference is important, as the two studies represent the only reported findings about the developmental progression of ToM understanding using the Wellman and Liu (2004) scale in children with HFA. Furthermore, they indicate disparate results indicating either delay (current study) or deviant development (Peterson et al., 2005). Therefore, the two studies will be examined in detail. Table 5-1 presents details from the aforementioned studies on the percentages of children with typical development and HFA who passed each task.

Table 5-1. A Comparison of Results from Studies using the Wellman and Liu (2004) Scale. These studies investigated the percentage of participants with typical development (TD) and high-functioning autism (HFA) passing each task; the circled cells represent two tasks passed in reversed order from the other studies

	Diverse Desire	Diverse Belief	Knowledge Access	Contents False Belief	Hidden Emotion
American TD (Wellman et al., 2004) *n* = 75 Age 2.92 - 6.5 (*M* 4.42 years)	95%	84%	73%	59%	32%
Australian TD (Peterson et al., 2005) *n* = 62 Age 3.83 - 5.75 (*M* 4.5 years)	95%	85%	82%	32%	19%
Australian HFA (Peterson et al. , 2005) *n* = 36 Age 6.25 - 14.17 (*M* 9.32 years)	86%	86%	75%	47%	64%
Scottish HFA (Current Study) *n* = 24 Age 8.58 - 16 (*M* 11.91 years)	92%	87.5%	58%	54%	37.5%

The Peterson et al. (2005) HFA group was younger than the group of children with HFA in this study, both in chronological age (2 ½ years younger) and verbal mental age (1½ years younger). However, information was not provided about the non-verbal skills of the Peterson et al. (2005) group; instead the authors noted that the children "were classed as high-functioning" (p. 505) and were required to have scored above a four year age-equivalent score on a test of receptive vocabulary. The children had all been diagnosed with ASDs based on the criteria from the Diagnostic and Statistical Manual of Mental Disorders, (4th Edition (DSM-IV), American Psychiatric Association, 1994) by a team of psychiatrists and clinical psychologists. The authors did not specify, however, whether or not children with Asperger syndrome were included or excluded and no pertinent information about evidence of early language delays was provided. Therefore, the rationale for the classification of HFA was not made explicit.

The current study used the identical Hidden Emotion task as the one presented in Wellman & Liu's (2004) original study about a child 'Matt' who was promised a toy car by his aunt but received a book from her instead. The child is asked to tell how 'Matt' felt about receiving a book from his aunt (which he didn't want; he was expecting a toy car) and to name the emotion 'Matt' would try to show on his face (because his aunt would not bring any more gifts if she knew he was unhappy with the book). However Peterson et al. (2005) presented the Hidden Emotion task using a story about a boy hiding his true emotion after being teased by a peer. As with the Hidden Emotion task in this study, Peterson et al. (2005) also presented a picture of the back of a boy's head whilst the story is told. The narrative of the story used in the Peterson et al. (2005) study follows:

> "A boy and his friends were playing. A girl teased the boy and the others all laughed. The boy did not laugh. He did not think it was funny. But the boy did not want the others to see how he felt. If they saw how he felt, they would call him a baby" (p. 517).

Thus, the Peterson et al. (2005) study presented a different story for the Hidden Emotion task but used a similar format. Although different, the story had similar length; the 'Teasing' story had 59 words, while the 'Matt' story used in the current study had 64 words. (The script for the 'Matt' story can be found in Appendix IV, page 255.) However, the Peterson et al. (2005) study, which also assessed groups of children who were deaf, "dropped [the] control question … because its length, conditional syntax and embedded phrase structure posed sign-translation and comprehension problems" (pp. 506-507). Thus, the syntax was more complex in the 'Matt' story, which included an embedded phrase in the question, "What will Matt's aunt do, if she knows how Matt really feels?" deVilliers and de Villiers (2003) found that embedded clause understanding predicted ToM ability in typically developing preschoolers but not vice versa. Therefore, the simplified syntax used in the Peterson et al. (2005) study may have resulted in the higher percentage (64%) of children with HFA passing that particular task, as compared to both the children with HFA in this study (37.5%) and the typically developing children in the Wellman and Liu (2004) study as shown in Table 5-1.

Additionally, Peterson et al. (2005) noted that they used a justification question instead of the eliminated control question with the embedded clause. Following the story, the child was asked "How did the boy really and truly feel when everyone laughed and teased him?" whilst pictures of happy, sad and okay were presented. Next the child was asked to justify the reason why the boy felt that way *before* being asked the critical "How would he try to look on his face" question. This justification question was not used in the current study, or in the original study reported by Wellman and Liu (2004). Therefore, it is possible that inclusion of the first justification question may have helped the child to understand more about the problem posed in the question by priming the child to respond with greater insight as to how the boy would try to look on his face.

Although Peterson et al. (2005) adapted the task, they presented it in the same way to all of the groups in their study, not only to those with HFA, yet there was no difference in the order of tasks passed by the groups of children with typical development or the two groups of deaf children (one group was comprised of deaf children raised by families with fluent signing ability; the other group was comprised of deaf children raised and educated in oral environments). Perhaps the task modifications did not have had any effect on the fluently signing deaf or typically developing children due to the normal developmental progression of their language skills, whilst elimination of the embedded clause in the 'Teasing' Hidden Emotion story may have bypassed the effects of language deficits, particularly syntactic deficits, in the children with HFA. However the deaf children raised in an oral (and not with fluent sign) environment, whilst also linguistically disadvantaged, followed the same progression as typically developing children. Possibly the oral-raised deaf children had poorer language ability than the HFA group, which could explain this discrepancy; however a direct comparison can not be made based on the information regarding language abilities provided in the report. The language skills of both groups of deaf children were coded on a scale of 1 to 6, based on sign-language ability ratings given by their classroom teachers; the oral-raised deaf children scored an average of 2.96. Peterson et al. (2005) reported that a score of 2 denoted a sign language vocabulary that was "somewhat smaller than the average signing child this age, but adequate for everyday communication" and a score of 3 indicated a sign language vocabulary that was "about average for children this age who communicate freely and fluently in sign" (p. 505). The language ability of the children with HFA was determined by verbal mental-age ($M = 7;10$ years) on a receptive vocabulary measure.

A further explanation for the dissimilar performance of the HFA groups across studies may be due to the difference between the chronological age and verbal mental age of each. The HFA cohort in the current study had a 2.69 year difference between chronological age and verbal mental age, whilst the Peterson et al. (2005) HFA cohort had a 1.49 year difference (in both studies the children's chronological age was higher than their verbal mental age). Dahlgren and Trillingsgaard (1996) suggested that "a discrepancy between chronological age and mental age is more important than mental age *per se* (italics original)" (p. 762). Therefore, this difference could possibly account for, at least in part, the greater success evidenced by the Peterson et al. (2005) HFA group on the 'Teasing' Hidden Emotion task. However, the HFA group in the current study outperformed the Peterson et al. (2005) HFA group on the Contents False-Belief task, which vitiates this explanation.

Peterson et al. (2005) explained their results differently, however. They suggested that the children with HFA were able to personally relate to the Hidden Emotion task to the extent that similar real life experiences that may have motivated them to use a "work-around" (Peterson et al., 2005, p. 514) that bypassed the need for false-belief understanding (which they did not do with the Contents False-Belief task). The authors stated that, "Emotional understanding certainly has real-world relevance for high-functioning children with autism, who may devise some alternative strategies to take account of their peers' real and apparent emotions to interact successfully with them, even though lacking a clear appreciation of their mental states" (Peterson et al., 2005, p. 514). Further, they contended that "painful direct social encounters with situations such as those portrayed in our [Hidden Emotion] task … may heighten the high-functioning autistic child's sensitivity to these special kinds of emotional situations" (Peterson et al., p. 514). The authors also speculated that the oral-deaf children "typically enjoy cohesive relationships and easy communication with their signing classmates", thus "the motivation to work out nonmentalistic ways of coping with hidden emotion may not arise as urgently" (Peterson et al., 2005, p. 515).

However, this explanation that the children with HFA were effectively accessing a strategy based on relevant social experiences does not seem tenable, given the pragmatic and social communication challenges that exist in this group.

Another possible explanation for the differences seen in the results of this study and those reported by Peterson et al. (2005) is the use of different methods of presentation used for the ToM scale; this study used a computerised adaptation of the scale with picture symbols, whilst the Peterson et al. (2005) group used a combination of pictures and object props similar to the original study conducted by Wellman and Liu (2004). However, Wellman et al. (2001) reported no significant differences emerged based on the presentation methods used in a large meta-analysis they conducted.

Unfortunately, an unequivocal answer to the question of deviance versus delay in children with HFA of the developmental progression of ToM knowledge in using the Wellman and Liu (2004) scale does not emerge based on these two studies. It is clear, however, that differences in ToM task variables, such as story content and the type of questions used, impacted results and prevented the ability to compare findings adequately. However, this study followed the protocol from Wellman and Liu (2004) more rigidly than did the Peterson et al. (2005) investigation and the HFA group was more clearly defined, providing at least preliminary evidence of a delay in early ToM abilities rather than deviance. Additional studies are needed to further clarify the progression of ToM abilities in children with HFA.

5.2.3.3 False-Belief Task

Results for performance on the Smarties false-belief task fall in between low and high percentages of individuals passing the false-belief paradigm in previously published literature. In the current study, 54% of the group of children with HFA passed the Smarties false belief task. This is a higher percentage than either the 20% reported by Baron-Cohen et al. (1985) or the 32% by Steele et al. (2003), but slightly lower than the 57% passing rate reported by Burnette et al. (2005). The children in the study by Baron-Cohen et al. (1985) were in the same chronological age range but had a lower average verbal mental-age (5;05 years compared to 8;03 years for the children in this study) which probably accounts for the superior performance reported for the HFA-T2 group.

Likewise, the children in the current study were chronologically older (mean 11;11 years) than the group in the investigation by Steele et al. (2003) (mean 8;09 years) which probably accounts for HFA-T2 group's better performance. The current study's HFA cohort included children with a mean chronological age that was close to that of the children in the study reported by Burnette et al. (2005), although they did not exclude children who might have had Asperger syndrome; this could explain why a slightly higher percentage of their group passed the task.

Another factor that may have influenced all the more recently published results could be due to practice effects with the ToM tasks. There has been a significant amount of research and intervention literature which has discussed the ToM challenges faced by children with ASDs/HFA, particularly regarding false-belief tasks. However, none of the aforementioned studies provide any information about knowledge regarding previous testing of false-belief ability in their clinical groups (including the current study). It is possible that any of these children may have completed the same or similar false-belief test before, perhaps even repeatedly; in fact one of the participants in the current study stated "I seen that before" when the Smarties task was administered.

Another issue regarding success or failure on false-belief tasks was asserted in a recent personal account written by a man with HFA (Nazeer, 2006); specifically, he described how and why children with HFA might not pass the Smarties task, stating:

> "The first part of the experiment elicits another wrong answer from them. They may be worried about giving yet another wrong answer. They've already been tricked once. Subject to these considerations, are the results from the second stage of the experiment reliable? Are the children's answers affected by 'test anxiety'? Are they trying to second guess the examiners? After all, the answer that first occurred to them has already been proven to be wrong once. Perhaps they do think of 'sweets' to begin with but change their answer because they don't want to be wrong in the same way again" (pp. 71-72).

In the current study, the children with HFA were given two false-belief tasks, the Smarties task and the Contents false-belief task from the Wellman and Liu (2004) scale. The same overall percentage (54%) of children passed both false-belief tasks. However, two children passed the Smarties task but failed the Contents false-belief task and two different children failed the Smarties task but passed the Contents false-belief. Perhaps, as Nazeer (2006) pointed out, the results reflected second-guessing the examiner rather than poor mentalising ability. Whilst the fact that 54% of children in this study passed both false-belief tasks provides reliability for the result reported, practice effects and the comments by Nazeer (2006) are issues to consider when interpreting these results and should be borne in mind in future research.

5.2.3.4. Effects of Story Length on Second-Order Tasks

Different levels of success were obtained on the two second-order ToM tasks used in the current study. Three children passed the Chocolate story task, but none of the 24 children with HFA passed the John & Mary story task. Both stories were scored with the same scoring criteria used by Baron-Cohen (1989) which required that the individual provide a full verbal justification that indicated second-order ToM understanding by referring to what one character thought the other character thought. In Baron-Cohen's (1989) study using the John & Mary story, none of the ten children were able to provide a correct response to the justification question. However, 90% of the children correctly answered all the memory questions as well as the reality question (where did John really go to buy his ice-cream), all of which were given to ensure the child understood the details of the story. Thus, Baron-Cohen (1989) concluded that the results were evidence of deviant ToM ability since language demands did not account for failure on the ToM task. Results from the current study contradict this assertion, as evidenced by a higher percentage of children failing the control questions on the John & Mary task, as opposed to those who failed the control questions on the Chocolate story, with the difference approaching significance. Therefore, at least to some extent, increased attention and/or processing demands required for the John & Mary story hinder evaluation of ToM understanding. Future studies should control carefully for the possible effects of language on ToM understanding and comparisons across studies similarly need to consider the language within tasks as an important variable in outcomes achieved.

5.2.3.5 Language and ToM

In this study, the total score for the Wellman and Liu (2004) ToM scale as well as the ToM aggregate score showed strong positive correlations with measures of receptive and expressive vocabulary, expressive language and receptive grammar, supporting previous findings (Happé, 1995; Astington & Jenkins, 1999; deVilliers & deVilliers, 2003; Fisher et al., 2005; Bibby & McDonald, 2005; Lohmann, Tomasello & Meyer, 2005). Of all the aforementioned correlations, the most significant statistical relationship occurred between the measure of receptive vocabulary and the ToM aggregate score. Additionally, the only correlation revealed between language and the second-order ToM tasks was found between the Chocolate story task and receptive grammatical ability. This finding supports previous assertions that grammar and ToM abilities may be uniquely related (Astington & Jenkins, 1999; deVilliers & deVilliers, 2003; Fisher et al., 2005). Although use of two-tailed correlations in the current study does not provide evidence of the direction of this relationship, an indication that grammatical abilities are necessary to develop false-belief ToM understanding was gleaned through examination of minimal grammatical age equivalents required for success on ToM tasks. In this study, all children with a grammatical age less than 5;04 years failed the false-belief task and all those with a grammatical age greater than 10 years passed. Additionally, all three children who passed the second-order task had a grammatical age greater than 9 years. These findings support those by Fisher et al. (2005) who examined the same relationship in 58 children (mean 10;09 years) with ASDs and reported that all children with a grammatical age below 5;09 years failed the false-belief tasks and all those with a grammatical age over 10 years passed. Further exploration of this relationship would be a useful endeavour for future studies.

5.2.3.6 Non-Verbal Cognition, Chronological Age, and ToM

No significant relationships were revealed between ToM and either non-verbal cognitive ability or chronological age. These results directly conflict with those reported by Steele et al. (2003) who found significant correlations between ToM ability, chronological age and both non-verbal and verbal cognition at both time points in a longitudinal study. The Steele et al. (2003) cohort was comprised of 57 children with ASDs for whom the maximum group verbal, non-verbal and full scale IQs were quite high at 118, 153 and 141, respectively, whilst the minimum IQs for the three were 51, 43 and 42. Therefore the cohort included a very broad range of abilities and included those with HFA and possibly Asperger syndrome (the authors did not include specific information about this). Additionally, the cohort's mean age was 7;08 years and 8;09 years at the two time points; thus the Steele et al. (2003) children were younger than the children with HFA in this study. Therefore it is possible that the differences in the cognitive skill range and/or chronological age accounts for the conflicting results. On the other hand, results from this study support findings by Muris et al. (1999) as well as those by Happé (1995) who reported no correlations between age and ToM using data from an older group of children with ASDs that was closer in chronological age (mean 12;10 years) to the children in this study (mean 11;11 years). The relationships between cognitive ability and ToM, as well as between chronological age and ToM, have not been clearly elucidated due to the varying cognitive skills and ages of participants in previous studies which make cross-study comparisons difficult. Therefore, more information about the extent and nature of how age, cognition and ToM abilities interact is needed.

5.3 Deviance versus Delayed Skills in Children with HFA

An important consideration of the language, prosody and ToM skills in children with HFA is whether any of all of these skills are deviant or delayed as compared to those of children with typical development. Rice et al. (2005) asserted that

> "the contrast between delayed versus deviant aspects of language shows considerable promise in providing an overarching perspective on the ways in which language impairments can be manifest ...[and] this contrast plays out differently across different dimensions of language, is most clearly revealed in longitudinal growth data, and hints at relative strengths and weaknesses across clinical conditions" (p. 22).

In their review of language abilities in children across the autism spectrum, Tager-Flusberg et al. (2005) concluded that the majority of children show both delayed and deviant language skills. Whilst as a group, the skills of the HFA-T2 children are progressing along a delayed but typical trajectory, indicating delay rather than deviance, inspection of the individual skill profiles indicates the presence of both delay and deviance, thus supporting the assertion by Tager-Flusberg et al. (2005). For example, as reported in the results chapter, deviant language use was apparent within some individuals in semantics (e.g., use of idiosyncratic word meanings) and grammatical constructions (e.g., use of deviant word order).

Results from the prosody assessment over time strongly support that, in and of itself, prosodic ability in children with HFA on highly structured tasks represents skills that are delayed and which progress in tandem with language ability as measured by receptive vocabulary. This supports the prediction of delayed ability over time made by Peppé et al. (in press). However, consideration of prosodic abilities within both structured and unstructured tasks as a whole, prosody appeared to be deviant in the majority of children with HFA in the current study, given the discrepancy between greatly improved ability in structured tasks but continued presence of AEP.

As discussed at length previously, results from this study indicate that ToM skills, as measured by the ToM scale, are delayed rather than deviant, thus sharply contrasting with the opposite finding reported by Peterson et al. (2005). However, higher level abilities such as those measured by second-order tasks continue to be elusive for a significant majority of those with HFA, which supports the notion that later ToM development may be deviant in children with ASDs/HFA. Therefore, as noted with language and prosody, consideration of the broadest profile of ToM skills indicates that ToM skill acquisition is both delayed and deviant.

The results from the current study therefore provide evidence that language, prosody and ToM skills are both delayed and deviant; this finding has implications for intervention for children with HFA. Speech and language therapists need to plan intervention not only to remediate skills following the developmental pathway seen in typically developing children, but also need to flexibly incorporate specific, individual goals targeting improvement for deviant aspects of skill development. For example, a twelve year-old child with an age-equivalent receptive vocabulary score of eight years requires intervention directed for skills that develop after that age, following the delay model. However, careful analysis of specific errors in that child might indicate that, for example, word order skill such as a use of subject-verb-object construction needs to be taught.

5.4 Diagnostic Boundaries

5.4.1 HFA and Specific Language Impairment

A diagnosis of specific language impairment (SLI) is given to a child where there is evidence of a "significant impairment in spoken language ability when there is no obvious accompanying condition such as mental retardation, neurological damage, or hearing impairment" (Leonard, 1998, p. 3). A diagnosis of SLI specifies that two of the required criteria for ASDs, namely impaired reciprocal social interactions and restricted activities must not be present. Therefore, by definition, SLI cannot be diagnosed in children with ASDs (Kjelgaard & Tager-Flusberg, 2001). However, as noted in Chapter 1, there has been considerable theoretical discussion regarding the overlap of the skills and deficits observed in *some* children with ASDs/HFA and those with SLI (Bishop, 2000; Bishop & Norbury, 2002; Botting & Conti-Ramsden, 2003; Conti-Ramsden et al., 2005). Results gathered from this HFA cohort on language, prosody and ToM deficits will be compared to findings reported for children with SLI to further elucidate the similarities and differences between these diagnostic groups.

Children with SLI, like those with HFA, have been described as comprising a group with considerable individual heterogeneity of language abilities (Conti-Ramsden et al., 1997; Leonard, 1998; Bishop & Norbury, 2002). Tager-Flusberg (2004) suggested that at least a subgroup of children with ASDs/HFA have a similar language impairment profile to that found in children with SLI, such as presence of language impairment without concomitant impairment in speech production (Kjelgaard & Tager-Flusberg, 2001). Bishop and Norbury (2002) reported mean standardised language scores obtained by 6 children with HFA and 11 children with SLI, matched on chronological age (mean 9;05 years). Both groups obtained mean scores similar to those obtained by the children with HFA in this study, as shown in Table 5-2.

Table 5-2. Comparison of Standardised Language Scores between Children with Specific Language Impairment (SLI) and High-Functioning Autism (HFA); the shaded columns represent results reported by Bishop & Norbury, 2002 and the column without shading represents data obtained in the current study

Measure	*Group*		
	SLI	HFA	HFA
	Bishop & Norbury, 2002		Current study
Non-Verbal Cognition	97.09	95.67	93.46
Receptive Language	78.35	77.69	75.42
Expressive Language	67.36	69.5	71.43

Kjelgaard and Tager-Flusberg (2001) found similar profiles of language performance in a subgroup of children with HFA, thus they suggested that at least some children with HFA may have a concomitant SLI impairment. Data from the current study supports this conjecture, as almost 55% of the HFA-T2 cohort presented with combined receptive-and-expressive-impairments (as determined by a standardised score falling below 1.5 SD below the population mean). Therefore a majority of the HFA-T2 cohort also met the language impairment criteria for SLI, which specifies that language scores must fall more than 1.25 SD below the mean, as delineated by Leonard (1998). Using the strictest criterion requiring individual non-verbal cognitive scores that are equal to or greater than 85 for a diagnosis of SLI (Stark and Tallal, 1981), nine children from the HFA-T2 group (37.5%) remain with a possible concomitant SLI disorder.

Further clarity on existence of a concomitant SLI impairment in some of the HFA-T2 children can be gleaned through examination of the scores obtained on the CCC-2 pragmatic skills questionnaire. Bishop (2003b) reported that children with SLI, as well as those with HFA, would be expected to score below 55 on the General Communication Composite, indeed 95% of HFA-T2 cohort had a score below 55. However, Bishop (2003b) also reported that children with SLI are expected to score above 9 on the Social Interaction Deviance Composite, children with ASDs are expected to score 8 or less, with those children who score between 0 and 8 showing an intermediate profile between the two conditions. Indeed, seven children from the HFA-T2 cohort achieved a score between 0 and 8 on this composite.

Previous research has revealed the presence of prosodic deficits in children with SLI, such as greater difficulty modulating stress patterns in conversational speech as compared to typically developing, age-matched children (Goffman, 1999). As the current study compared prosodic ability of children with HFA to children matched by language-age rather than by chronological age, a direct comparison cannot be made. However, given that the HFA cohort in the current study, as a group, scored lower than the language-age matched group of typically developing children on expressive and receptive use of contrastive stress, it is a fair assumption that comparison with a group of typically developing children matched on chronological age would reveal the children with HFA to be significantly poorer on stress tasks. Baltaxe and Simmons (1985) reported similarities between children with ASDs and SLI matched on mean length of utterance using instrumental measurement of intonational contours such as fundamental frequency range, terminal fall (marking the end of an utterance with stress and a fall in pitch) and "covariation of frequency and intensity over the entire intonational contour" (p. 109). Both the ASD and the SLI groups showed less stability overall and more individual variation as compared to a group of younger typically developing children (also matched on mean length of utterance). Nielsen (2005) found that four children with SLI (mean 7 years) performed comparably to a chronological age-matched group of four typically developing children on production of contrastive stress; however, the children with SLI had intonation patterns which became more atypical as the length of utterance increased. Thus, Nielsen (2005) suggested prosodic problems could account for the deficits in short-term memory found in those with SLI.

There are mixed findings regarding the ToM abilities of children with SLI. Miller (2004) assessed false-belief understanding in 15 children (mean 4;11 years) with SLI and found that they performed similarly to a group of typically developing children matched on chronological age and another group matched by language comprehension level. Farrant, Fletcher and Mayberry (2006) assessed ToM ability using the Wellman and Liu (2004) scale in 20 children with SLI and 20 children with typical development. The groups were matched on non-verbal ability, gender and chronological age (mean 5;03 years). As compared to the typically developing children, the SLI group performed significantly worse on the total ToM score. Additionally, the SLI group also performed significantly worse on the memory questions on the Hidden Emotion task. The authors concluded that this was due to either to the linguistic complexity of the Hidden Emotion task or the length of narrative involved. Unfortunately, the authors did not report the percentage of children passing each task, which prevents direct comparison with findings in this study, as well as with those reported by Wellman and Liu (2004) and Peterson et al. (2005). However, with one study showing equivocal abilities between children with SLI and those with typical development and another showing evidence of a delay which was argued to be a result of language impairment (Farrant et al., 2006) it does appear that ToM skills and challenges are different in those with SLI and HFA.

The language, pragmatic and non-verbal cognitive profiles of seven individuals with HFA in the current study show striking similarities to those seen in children with SLI, as evidenced by comparison of the profile of scores obtained on the standardised assessment measures with previous reports in the literature. Further, there is some evidence that aspects of prosodic ability are impaired in children with SLI, supporting the aforementioned contention of diagnostic overlap. Anecdotally, several children in the HFA-T2 cohort presented as children with impaired language ability first and foremost (e.g., had difficulty with task directions, required more repetitions of stimuli), whilst some presented as more classically like those with HFA (e.g., more socially aloof). This has direct clinical implications for speech and language therapists, as intervention guidelines differ for school-aged children with HFA and those with SLI. For example, therapists tend to focus on social interaction skills in children with HFA, whilst in those with SLI, intervention is generally directed toward improving language understanding and formulation. Evidence from the current study indicates therapists need to be aware of a possible diagnostic overlap. Experienced therapists should employ their clinical knowledge by designing and adapting intervention and assessment sessions based on all presenting characteristics, rather than based on the diagnostic label. Less experienced therapists may not feel empowered to do so. However, results from this study show that children with HFA may require ongoing intervention for improving language structure and meaning. Additionally, speech and language therapists need to inform parents, carers and other professionals, such as educators, that children with HFA may have significant, persistent language deficits that will affect access to curriculum and acquisition of independent living skills.

More in-depth investigation of prosodic ability in children with SLI would be particularly warranted, using a structured assessment such as the PEPS-C. ToM skills appear to be fairly intact in children with SLI, except for a possible delay in acquisition due to language demands of tasks, although more studies on ToM ability in children with SLI are needed to clarify this. Perhaps ToM abilities ultimately differentiate between those children who show shared characteristics of HFA and SLI; this would be a fruitful area for future research.

5.4.2 HFA and Asperger Syndrome

In the current study, there were three children with HFA whose semantic and syntactic abilities have developed over time into the normal range. These children warrant comparison to children with Asperger syndrome (AS). By definition, children with AS are part of the autism spectrum but do not have a history of early language delay or language impairments, thus children with AS are unlike those with HFA. However, this distinction is tentative and controversial, with dubious clinical utility (Szatmari, 1998; Mayes, Calhoun & Crites, 2001; Ghaziuddin & Mountain-Kimchi, 2004). For example, children with HFA may present in later years similarly to those with AS; therefore presence of an early delay in speech and language does not preclude the development of language abilities to match those with AS (Mayes et al., 2001). Likewise, the lack of an early speech or language delay does not preclude language impairments in later years (Eisenmajer et al., 1998).

The three children who scored within the normal range on language assessments outperformed all the impaired-language groups, as well as the HFA-T2 group as a whole, on the language assessments. Two of these three children also obtained scores from the CCC-2 questionnaire that indicated conformity with pragmatic skill profiles expected for children with AS. Both children scored higher on the General Communication Composite than the HFA group and lower than the group on the Social Interaction Deviance Composite, showing a larger discrepancy between skills on structure and form of language and social interaction skills, as compared to the rest of the HFA-T2 cohort. The children's scores for this composite were -14 and -15; Bishop (2003b) reported that composite scores of -15 or less are frequently obtained by children with Asperger syndrome.

Poor prosodic ability in children with AS, like in children with HFA, has been described as a clinical feature of the condition (Asperger 1944/1991; Wing, 1991) but it is not an imperative symptom. Children with AS may also have atypical expressive prosody (Asperger, 1944/1991; Klin et al., 2005) which has been described as pedantic (Ghaziuddin & Gerstein, 1996). McCann & Carroll et al. (2006) assessed receptive and expressive prosody in children with AS using the PEPS-C and compared results to a group of typically developing children matched on verbal mental age. There were no significant differences between groups on 11 out of 12 subtests; this is similar to the skills of the HFA-T2 group as compared to verbal age matched peers in the current study. However, as reported in Chapter 2, Fine et al. (1991) found that use of contrastive stress was less communicatively functional in children with HFA than those with AS or typical development. It is also possible that use of a prosody assessment that assesses higher level tasks, such as understanding and using prosody for sarcasm and irony may show differences, especially since there were ceiling effects on the PEPS-C.

ToM ability has been reported to be better in children with AS compared to those with HFA (Gillberg & Ehlers, 1998); this is unsurprising given the higher language abilities seen in those with AS and the strong correlation between ToM and language. However, as with all children with ASDs, mentalising abilities in those with AS are poorer than those found in typically developing children (Ozonoff & McEvoy, 1994). Results from this study support the contention that those with AS do better than those with HFA, but still show difficulty; the three children who scored within the normal limits on language form and content measures did outscore the rest of the HFA group on the ToM aggregate score and the Wellman and Liu (2004) scale. However, only one of these three children passed the Chocolate Story second-order task.

Evidence from the current study supports the contention that, at least for some children with HFA, early differences between the language skills of these children and those with AS may disappear in later years. However, higher order language abilities such as understanding metaphors and figurative language as well as extended narrative and discourse abilities were not assessed in the current study. It is possible that assessments would show differences between those with HFA (with language skills within the normal range) and those with AS, or that both groups would have difficulty with such tasks.

5.5 The Nature of the Relationship between Language, Prosody and ToM

Results from this study showed that language, prosody and theory of mind are interrelated. The heterogeneity of skills and deficits in these areas modulate the overall impact on social interaction and communication, thus differentially affecting access to education and response to intervention. Where might these deficits begin, and at what point do these areas interact? In the following section, it will be argued that early attention to prosodic cues and interest in social interactions significantly impact joint attention abilities and subsequently language and ToM ability, with reference to findings reported in the research literature.

5.5.1 Evidence from Studies of Joint Attention and Social Interaction

Gerber (2003) postulated:

> "The origins of language *use* are found in the social engagement and connectedness between babies and caregivers. Here, the motivation for learning language is the infant's need to sustain intersubjectivity with other persons. Infant and caregiver eventually move from interactive contexts with shared affective meaning to contexts in which meaning is shared in speech. That infants can participate in organized meaningful exchanges long before language begins has enormous implications for intervention with children who have not yet developed this capacity .... Only if engagement, affective and emotional expression, contents of mind, and intentionality are sufficiently developed will the child be ready to begin to develop language" (pp. 76-78).

Joint attention behaviours facilitate attention and interaction between a child and a communicative partner to share awareness of objects or events (Mundy, Sigman & Kasari, 1990) and include the regulation of mutual attention, via vocalizing to attract attention to oneself, and pointing at something while vocalizing (Rollins & Snow, 1998). While joint attention is typically described as shared gaze and/or the use of declarative vs. imperative gestures and proto-declarative pointing, it has also been noted that one way of initiating attention is also through the use of verbal comments (Bono, Daley & Sigman, 2004), vocalizations (McArthur & Adamson, 1996) or attending to the auditory input of another individual (Carpenter et al., 1998). Carpenter and Tomesello (2000) noted that joint attention requires a child to be able to attend to and gather salient information from facial expressions, vocalizations, and/or physical gestures and interpret these as communicative intents. Therefore it is conceivable that if a child is deficient in the vocal aspect of joint attention, such a deficit could possibly affect the outcome of the understanding and use of prosodic features and, possibly, language and ToM development.

Investigations of joint attention in children with autism have led to important findings about this skill. Joint attention has been found to be an important factor in the early diagnosis of autism and when it is deviant, has also been demonstrated to negatively affect future social interactions and language development (Charman et al., 2003). McArthur and Adamson (1996) found that, even in the company of nurturing adults actively attempting to solicit a child's shared attention, children with ASDs rarely engaged in joint attention. In a longitudinal study, Mundy et al. (1990) found that 15 children with ASDs showed a deficit in nonverbal joint attention skills and these skills were a significant predictor of their language development 13 months later. Similarly, Sigman & Ruskin (1999) reported that the children with ASDs who responded more frequently to bids for joint attention from others made stronger language gains over a period of nine years, whilst those who had a deficit in both initiating and responding to joint attention retained this deficit almost 9 years later. Bono et al. (2004) gathered data to support a moderately-sized relationship between more frequent initiation of joint attention by children with ASDs and greater increase in language age. Mundy et al. (1990) also reported that joint attention skills reflected concurrent receptive and expressive language abilities. Rollins and Snow (1998) found a strong correlation between joint attention and the development of grammatical skills as measured by performance over time on a measure of syntax; specifically, the children who demonstrated little or no establishment or maintenance of joint attention had the poorest language development. Tager-Flusberg (2000a) asserted that early deficits in social interaction are likely to impact on prosodic ability, stating that "Prosodic deficits may also be related to … the fact that infants with autism pay so little attention to the speech of others in their environment" (p. 9). Further, Tager-Flusberg (2000a) highlighted the fact that prosodic deficits are one of the earliest signs of ASDs, noting that infants with ASDs produce vocalisations that mothers of other infants with ASDs have difficulty interpreting. In sum, these studies have indicated that joint attention is clearly impaired overall in children with ASDs and appears to lead toward poorer prognoses for language and social development.

5.5.2 Theoretical Model of Early Interaction between Language, Prosody and ToM

Empirical evidence supports the importance of joint attention in infancy to the later development of social responsiveness, language and social interaction skills. Early joint attention skills also have a critical role in the development of language and ToM, both in typically developing children and those with HFA. It has been reported that many infants who are later diagnosed with ASDs lack responsiveness to the faces and voices of others, although it is hard to determine if this is always the case, as such reports are usually retrospective, due to the later diagnosis. Given that this contrasts with the early social responsiveness of typical infants, it could that be that the following chain of events occurs. Decreased early social responsiveness, including lack of attention to faces and voices, leads to impaired prosodic attention by the age of nine months. Subsequently, impaired attention to prosodic cues may negatively impact on language development through inability to benefit from prosodic bootstrapping as well as mentalising which, in turn, negatively impacts on later language and social interaction skills. This theoretical progression is illustrated in Figure 5-2. The model assumes normal cognitive potential, as it is a discussion about those children who eventually are labelled HFA. However, there is evidence that there are differences in the brain structure in children with ASDs occurring in the prenatal or neonatal period (Bauman & Kemper, 1994; Bailey et al., 1998), so there may be cognitive implications due to these factors that are not apparent in the testing on non-verbal cognitive ability.

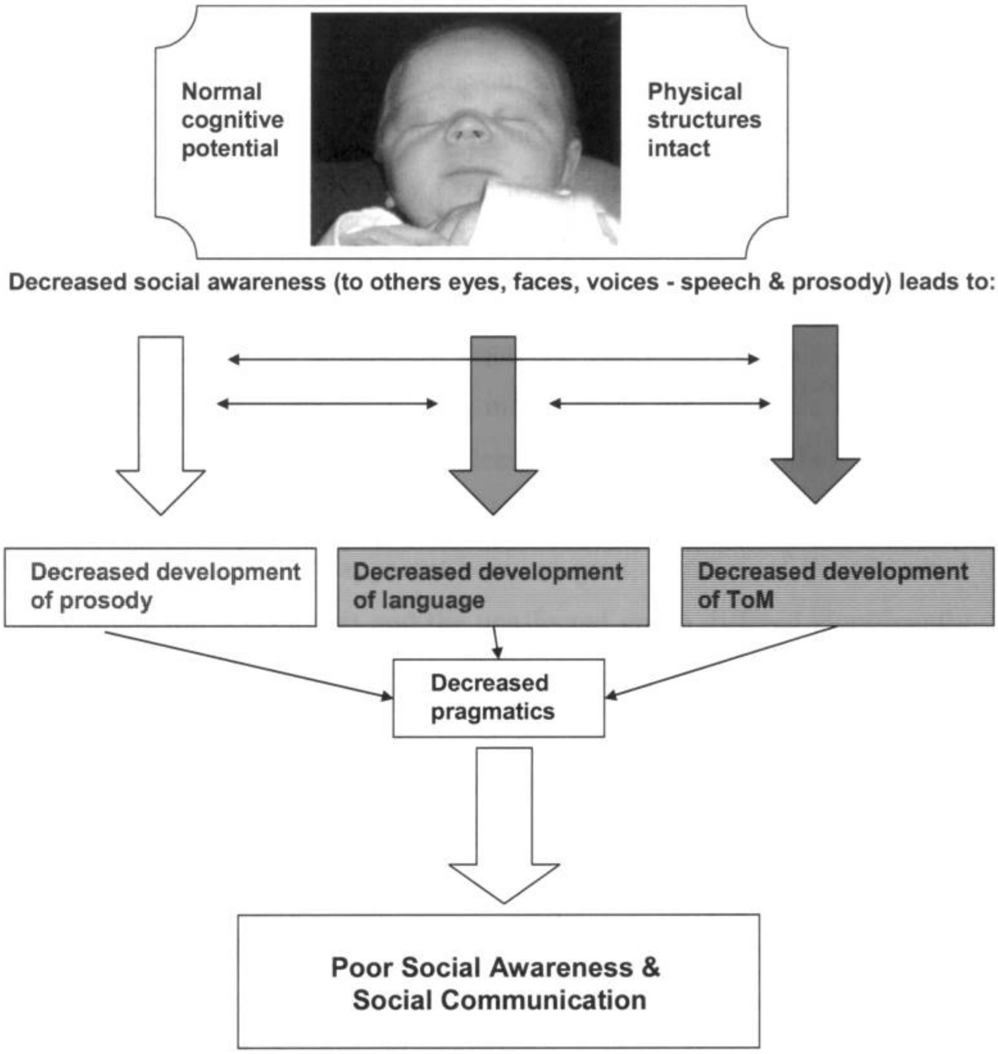


Figure 5-2 A Theoretical Schematic Diagram Representing a Possible Early Interaction between Language, Prosody and ToM

A recent study by Landa and Garrett-Mayer (2006) lends some support to this conjecture of early, interacting deficits. They conducted a prospective study of 87 infants; one group (n = 60) was considered at a high risk for developing ASDs (due to siblings with that diagnosis) while the others were low risk (no family history of ASDs).

The infants were assessed with the Mullen Scales of Early Learning (Mullen, 1995) at 6, 14 and 24 months for gross and fine motor, visual reception and receptive and expressive language skills. Additionally, at 24 months all infants were assessed with the Autism Diagnostic Observation Schedule (Lord et al., 2000) and the Preschool Language Scale-IV (Zimmerman, Steiner & Pond, 2002). By 24 months of age, 28% of the infants met the ADOS criteria for autism. The diagnosis was then confirmed by clinical judgment of a speech and language pathologist or psychologist; Woods & Wetherby (2003) have reported that experienced clinicians can make a reliable diagnosis of ASDs at 24 months. Landa and Garrett-Mayer (2006) acknowledged that 28% incidence represented a surprisingly higher percentage than would have been expected and suggested that of the infants that began the study at 14 months of age, participation bias may have been a factor. Eleven infants were diagnosed as showing a language delay (but not autism) and 52 were deemed unaffected by either ASDs or language delays. The results of this study showed that, whilst at 6 months of age no statistically significant differences were apparent between groups on any of the measured domains, by 14 months the ASD group and the unaffected group differed significantly, with the infants with ASDs showing poorest performance on all measures except visual reception. At 24 months, the ASD group performed significantly below the unaffected group on all measures. The authors concluded that, in infants with ASDs, early development appears to progress normally until somewhere between 6 and 14 months, where it slows and worsens. Further, they suggested that their results indicated that the period between 14 and 24 months is "one of particular vulnerability for toddlers with ASD" (Landa & Garrett-Mayer, 2006, p. 635). Thus, Landa and Garrett-Mayer's (2006) findings coincide with the theoretical assertion made by this author that sometime before the age of nine months, when typical infants begin to reliably understand and differentiate prosodic distinctions, those with ASD perhaps do not, or do so unreliably. Therefore, early prosodic deficits may possibly result in, or exacerbate, subsequent or concurrent deficits in language and ToM skill development.

5.6 Implications for Assessment and Intervention for HFA

Although the following sections discuss assessment and intervention as separate and distinct topics for clarity as discussion points, each should be considered as integral to the other (Twachtman, 1995). Therefore, during intervention, skills must be re-evaluated; likewise, therapeutic methods should be employed in some aspects of the assessment process.

5.6.1 Assessment

As discussed in section 5.2.1.2, results from this study have shown that assumptions cannot be made about the trajectory of skills in individual school-aged children with HFA. Some children may have concomitant specific language impairments, whilst others may show language skills that have developed into the normal range and present with a profile similar to those with Asperger syndrome. However, the areas of language, prosody and ToM are vulnerable in the majority of school-aged children with HFA while pragmatic skills continue to be universally impaired. Therefore, this study has provided evidence that language, prosody, ToM and pragmatic skills warrant assessment throughout the school years, although an appropriate assessment battery will need to be conducted based on individual characteristics, as will be discussed below.

For the children with language impairments, assessments of receptive and expressive semantics and syntax should be conducted on a yearly basis to determine the most current level of skills in children with HFA. Additionally, an omnibus test of receptive and expressive language which has subtests that assess several areas of language in tandem should be conducted. Phonology and articulation will also need to be reassessed if there has been delayed development. Speech and language therapists working with school-aged children also need to assess the child's language, pragmatic and social communication skills that are necessary for academic success, such as the ability to make inferences from verbal and written language, as well as narrative and discourse abilities (Naremore, Densmore & Harman, 2001). Social interaction and pragmatic skills require informal assessment such as observation of the child in interactions as well as gathering and analysing language samples. These methods can simultaneously provide information about the child's ability to understand the listener's needs as well as his/her ability to flexibly and competently use implicit conversational rules (Twachtman-Cullen, 2000). It is also recommended that a questionnaire, such as the CCC-2, be used to gather information about pragmatic skills on a yearly basis. In the current study, the CCC-2 was completed by the children's parents; perhaps it would be even more useful if every other year it was completed by a classroom teacher to get an inventory of the pragmatic behaviours in the classroom. The combined information from the parent and teacher would provide a broader perspective of the social pragmatic skills of the child.

Regarding assessment for prosodic abilities, speech and language therapists usually focus on providing descriptions of atypical expressive prosodic deficits. Such descriptions are important, and may reflect an expressive prosodic style that is overly exaggerated, or that which is overly monotonous. However, Hargrove & McGarr (1994) noted that therapists have had difficulty achieving a balance between oversimplified and overly specific descriptions of prosody that are useful for clinical assessment. This is an area that needs further research to determine the nature of atypical expressive prosody deficits and eventually, to provide clinical guidelines for assessment. Results of this study provided evidence that children with atypical expressive prosody are also more likely to show also difficulty with understanding and using prosody within structured tasks. However, prosodic abilities within structured tasks have not been routinely or comprehensively assessed due to the unwieldy nature of assessment tools as well as a reflection of prosody as an under-examined facet of communication, both in the field of speech and language, as well as in research (Hargrove & McGarr, 1994). However, results from the McCann et al. (in press) study showed receptive and expressive prosody skills were impoverished in children with HFA as compared to typical peers. Additionally, results from the current study indicate that not all children with HFA improve prosodic abilities over time to match the ability level of verbal mental-age matched peers. Therefore the receptive and expressive features assessed by the PEPS-C (hearing similarities and differences in prosodic contours, use of prosodic contours to distinguish between questioning and stating as well as to indicate affect, use of pausing to delineating phrase boundaries and contrastive stress) provide practical parameters for assessing prosodic abilities. The PEPS-C assessment measure, currently being revised for use in clinical settings, has the potential to become a useful tool as it is the only comprehensive measure of receptive and expressive prosody in structured tasks for school-aged children. However, the version used for the current study showed inherent limitations, such as ceiling effects and the need for extensive training and experience with the tool to achieve acceptable inter- and intra-rater reliability. Further discussion of the limitations of the PEPS-C will be presented in the section evaluating the methods used in the current study.

Miller (2006) asserted that speech and language therapists should include ToM as part of a comprehensive assessment of a child's communication ability. Indeed, the research literature has provided rich evidence of the importance of language to ToM, as well as the role of ToM in social communication and pragmatics. Results from the current study also provide evidence that assessment of ToM in children with HFA should be undertaken, as the outcomes provide an indication of a child's level of ToM ability and therefore can provide specific targets for intervention. The ToM assessment battery used in the current study covered a broad developmental range that would be useful in clinical practice for school-aged children with HFA. For children who are able to pass the second-order tasks, use of Happé's Strange Stories (Happé, 1994) would provide further information about higher level skills.

In addition to the need for ongoing assessments using measures that can show change over time, there is a need for assessment of social communication, language, prosodic ability and ToM in real life settings across a variety of communication partners. On their own, standardised assessments are gross estimates of ability that do not reveal more subtle difficulties in children with HFA (Twachtman-Cullen, 2000). Combining standardised measures with observations of a child's skills and deficits across different contexts will yield a more complete and accurate picture (Wetherby et al., 2000). For the heterogeneous group of children with HFA, such assessments are critical due to the need to identify unique learning styles and the subsequent individualised intervention to be designed as a result (Mesibov, Troxler & Boswell, 1988). Information should be gathered about the school, home and community environments; specifically where skills are problematic within a particular environment, communication partner/partners or social context (RCSLT, 2006), as well as contexts and situations in which strengths are observed.

5.6.2 Intervention

5.6.2.1 Intervention for School-Age Children with HFA

Language skills are continuing to develop in children with HFA whilst, for the majority, continuing to be impoverished as compared to typically developing peers. This evidence indicates that continued language intervention is warranted, even in adolescent children with HFA. Moreover, this evidence can provide support for speech and language therapists to justify the need for ongoing intervention with these children. As discussed in Section 5.3, intervention needs to be highly individualised to account for areas of deviance and delay, whilst utilising the child's strengths. The children who have developed language skills within the normal range may need intervention for more abstract, higher order language skills, such as use of narratives and discourse, as discussed in Section 5.4.2.

Although not a planned outcome measure for this study, examination of change in prosodic ability in the three children who received intervention provided an indication that prosody therapy (targeting receptive ability) may be effective to increase both receptive and expressive prosodic ability in school-age children within structured tasks. However, AEP may require earlier intervention, as will be discussed in the following section. As a result of their research into prosodic abilities and challenges in children with HFA, McCann, Peppé, Gibbon, O'Hare and Rutherford (2006) have provided some strategies for families and carers of children with ASDs/HFA. These are only suggestions, however, as they have not been validated through intervention studies. For example, a communication partner should not expect that a person will clearly indicate the desired affect in an utterance; therefore the partner should explicitly ask the child how he or she is feeling rather than making an assumption based on prosody. Likewise, when speaking to a person with ASDs/HFA it is important not to assume he/she will understand the speaker's emotion from prosody alone; he/she should be told. Speech and language therapists should incorporate redundancy and explicit instruction about the subtleties inherent in prosodic features. Additionally, this study has provided evidence that contrastive stress is the prosodic feature that is the most impaired in structured tasks in children with HFA, therefore, intervention for this prosodic feature should be conducted.

Results from the Children's Communication Checklist clearly indicated that social and pragmatic skills continue to be considerably impaired in the children with HFA over time and therefore need ongoing intervention. Additionally, since the results of this study have shown that the majority of children with HFA continue to show language, prosodic (in spontaneous conversation) and ToM mind deficits well into the school years, combining these areas in social skills intervention would likely be a fruitful method. Shea and Mesibov (2005) encouraged professionals to "explicitly teach social and emotional topics and techniques for fitting in better, if not completely, with the customs of their social world" (p. 303). Social stories can be usefully employed for this type of explicit instruction (Gray, 1998) whilst also being flexible enough to pertain to an individual's unique profile of skills, deficits and personal interests. Howlin, Baron-Cohen and Hadwin (1999) provided an instruction book to teach ToM abilities, however the activities could be tailored to incorporate features of language, prosody and social instruction in tandem. Wellman et al. (2002) reported that using focused teaching about ToM in which peoples' beliefs are likened to cartoon thought bubbles was a useful strategy for children with ASDs. As with the Howlin et al. (1999) activities, use of thought bubbles could be expanded to incorporate language, pragmatic and prosodic understanding, as well as ToM, by making implicit knowledge explicit and therefore accessible to those with HFA.

5.6.2.2 Intervention for Infants at Risk for ASDs/ HFA

As discussed, research on the typical development of prosodic abilities has shown that significant developments occur within the first year of life. For infants, evidence suggests that explicit training in joint visual and auditory attention is critical to later language and social development (Charman et al., 2003; Bono et al., 2004). Therefore, intervention methods to use with infants at risk for ASDs (due to family history), or who show poor social interaction or social interest, should be developed and then followed up with longitudinal investigations of efficacy in later years. It may be beneficial to explicitly draw attention to a variety of prosodic contours within meaningful contexts. For example, auditory stimuli could be used to gain and maintain attention to things that are rewarding to the infant; at feeding time, the carer could present prosodic contours that indicate positive affect (such as mmm-mmm) or one- and two-word phrases paired with a tangible reward (e.g., bottle). At the age of one year, imitation tasks (within natural interactions) such as 'oh, oh' and 'all gone' should be emphasised. The carer should receive ongoing support to continue to use these contours even if the infant does not respond positively, as the carer may become discouraged and discontinue such verbal interactions. With children aged around one year, carers should begin to explicitly label emotions with direct attention given to facial expressions, prosodic expression of affect and intonational contours as well as body language. At the age of two years, this explicit labelling should continue with short reasons and/or explanations as to why someone is feeling or behaving a certain way. For example, saying 'Mummy is happy. See mummy's face? This is happy. Listen to mummy's voice. Mummy said 'Hi Daddy!' Mummy is happy to see Daddy. Daddy is happy. See Daddy's face? Daddy is happy to be home. Hear Daddy's voice? Daddy said 'Hello baby.' (providing a repetition of the affective prosody used by 'Daddy' to indicate happy). Additionally, stories could be used that have short vignettes in which facial expression, body posture and voice are explicitly pointed out.

These stories could gradually become more complex and include short stories such as those by Howlin et al. (1999) and Gray (1998) that begin to address ToM abilities, in addition to explicit teaching of prosodic and facial expressions. The ToM stories could progress in a manner similar to the progression in the Wellman and Liu (2004) scale, focusing first on diverse desires. These early ToM stories could also explicitly use contrastive stress. For example, an early diverse desire story could be about two characters wanting different kinds of biscuits (one only wants a plain biscuit, the other only wants a chocolate biscuit and each are surprised to learn the other character likes a different kind of biscuit from him/her). Use of such stories would also be helpful for the carer who wants to provide opportunities to teach skills, but feels ill-equipped to teach a young child with ASDs. Experience reading these stories may also help the carer to become aware of naturally occurring opportunities to explicitly point out and explain situations in which such ambiguities are present.

5.7 Evaluation of Study Methodology

5.7.1 Participants

5.7.1.1 Children with HFA

With a cohort of 24 participants with HFA, this study represents a large clinical group, since studies with twenty or more children with HFA are rare (Peterson et al., 2005). Additionally, this group of children comprised a tightly-defined group of children with HFA, adhering stringently to criteria reported in the literature (Baltaxe and Simmons, 1992; Tsai, 1992; Waterhouse, 1996; Gillberg & Ehlers, 1998; Szatmari et al., 2003; Howlin, 2003; Starr et al., 2003; Klin et al., 2005; Landa & Goldberg, 2005). Therefore, the results should be generalisable to other school-aged children who have been carefully labelled HFA.

5.7.1.2 Children with Typical Development

The typically developing (TD) children used as a control group to compare prosody and receptive vocabulary skills at T2 were matched on verbal mental age as determined by the language age score of the British Picture Vocabulary Scale. This is the same method of matching that has frequently been used in previous studies (Mottron, 2004), as well as with the children with HFA at T1 (McCann et al., in press). However, the TD children were not the same children assessed at T1. Therefore, although a reasonable comparison can be made regarding the prosody and receptive vocabulary skills between groups at each Time point, the T2 data from the TD group does not represent growth within each individual TD participant as it does in the HFA participants. On the PEPS-C assessment, for example, the HFA participants had all completed the assessment previously. The TD children only completed it once. Perhaps if the same TD children from T1 had been reassessed, they may have actually performed better due to the previous experience with the assessment tool. On the other hand, having at least some data from TD children is useful, even if it is not completely comparable. Another drawback regarding the TD children is the lack of data from the ToM assessment. As there is no data available yet from the Wellman and Liu scale (2004) to show that children in Great Britain follow the same developmental pattern as American and Australian TD children, one can not assume they do. However, given the similarities between the countries (e.g., English speaking, western culture) as well as evidence from false-belief studies in America, Australia and UK, it is likely that typically developing British children do follow the same progression. However a study examining this is warranted.

5.7.2 Assessment Measures Used

5.7.2.1 Language, Non-Verbal Cognition and Pragmatics

The entire protocol of language, non-verbal cognitive, and pragmatics assessment measures consisted of those which were appropriate for the chronological age range of the HFA group and the majority provided normative data from British children, thus representing a sound psychometric basis for assessment (Conti-Ramsden et al., 1997). Although both the Goldman-Fristoe Test of Articulation and the Expressive One-Word Picture Vocabulary Test-Revised (EOWPVT-R) provide standardised scores based on normative samples from children in the U.S.A., both tests have been used regularly in studies of British children (e.g., Goldman-Fristoe in Conti-Ramsden et al., 1997; Botting, Faragher, Simkim, Knox & Conti-Ramsden, 2001; Glogowska, Roulstone, Peters & Enderby, 2006; McCann et al., in press; EOWPVT in Baron-Cohen, 1989; Mawhood, Howling & Rutter, 2000; Howlin, 2003; Howlin & Karph, 2004). Additionally, results from the current study support the use of the Expressive One-Word Picture Vocabulary Test with British children, as expressive vocabulary scores correlated highly with the other measures of language used in this study.

The change at T2 to the updated versions of the Test for Reception of Grammar (TROG) and the Children's Communication Checklist – 2 (CCC-2) prevented detailed examination of skills over time, although a standardised score comparison across the versions of the TROG was possible. The CCC-2 included different questions than the earlier version; in particular questions from the first version which queried skills relating to prosody were eliminated, which may explain the lack of correlations found between prosody and pragmatics (D. Bishop, personal communication, 12 May, 2005). A more comprehensive assessment of pragmatic ability conducted in tandem with the CCC-2 questionnaire would have been useful and may have provided greater insight on the relationship between pragmatic and prosodic abilities.

5.7.2.2 Prosody

The prosody assessment measure (PEPS-C) is not a standardised assessment, therefore individual comparison of the skills of each child with HFA is limited to single verbal-aged matched TD child, rather than to a systematically determined relationship to those with typical development, as would be possible with a normative sample. Statistical analyses were conducted using raw scores from the PEPS-C and showed a significant relationship with the raw scores on the BPVS. However, it is possible that data from a large, standardised normative population would show different results.

As discussed in the methodology section, overall inter- and intra-rater agreement for the HFA group performance on the PEPS-C expressive tasks were high when compared by individual subtest as well as across participants. The lowest reliability occurred on the inter-rater agreement on the Affect output task (which required the child to say the name of a food in a way that would indicate if the child did or did not like the food). Additionally, while the inter-rater mean agreement across 25% of the HFA-T2 participants (n = 6) was 94.9%, there was one participant for whom the inter-rater agreement was much lower (82.6%). This participant was judged to have AEP which could be described as flat or monotonous. On the affect output task, he named every food in the same manner. This examiner judged all his responses as indicating he liked the food, whilst the other listener judged all his responses as indicating dislike. Clearly, this participant did not provide effective information from prosody alone to indicate like or dislike. On the other hand, the fact that both raters made a consistent judgment across each of his responses provides confirmation that he was producing his responses in the same way. As was noted in the methodology chapter, the six participants used for the rating agreement analyses were chosen randomly. Two of the six participants (33.3%) were not considered to have AEP, whilst the remaining four did. Interestingly, the highest inter-rater agreement occurred with one of the participants with AEP; therefore, presence of AEP does not always preclude that speaker's ability to clearly indicate communicative intent on structured prosody tasks nor does it always preclude a listener's ability to rate the intention of a speaker with AEP on performance on structured tasks.

The inter- and intra-rater agreement scores do support the use of the PEPS-C as a valid assessment tool. However, therapists using the PEPS-C should undergo extensive training on the tool before administering it in clinical settings. For the ratings reported in the current study, both therapists/examiners had administered the PEPS-C assessment more than 50 times each by the time the agreement scores were calculated. Additionally, each rater had extensive experience listening to the speech of children with HFA. Further information regarding the effectiveness of listener judgment on the output tasks of the PEPS-C with less experienced examiners is warranted.

The presence of ceiling effects indicates that the prosody assessment measure did not assess a broad enough range of abilities, either with the typically developing children or those with HFA. Whilst it is still recommended as a useful assessment for prosody, the assessment will need to be broadened to include higher level abilities such as understanding and using prosody for irony and sarcasm. The PEPS-C can usefully determine the level of receptive and expressive prosodic skills within structured tasks. This is a much needed assessment tool for speech and language therapists; however normative data from typically developing children should be included in the assessment package. Additionally, guidelines need to be carefully and thoughtfully provided regarding how frequently such an assessment should be used.

5.7.2.3 Theory of Mind Assessment Measures

The adapted version of the Wellman and Liu (2004) Scale tasks for presentation on the computer enabled use of recorded narratives, thus assuring that all stimuli were presented with the exact same verbal and prosodic information to all participants. The computerised adaptation of the Wellman and Liu (2004) scale has good potential for future use as an assessment tool. Computer activities are generally motivating for children with HFA. Use of recorded narratives adds an important control for prosody and/or semantic content, thus ensuring that these are not additional confounding variables. For example, on a certain day, a researcher may be slightly less enthusiastic and this may be subtly evident in prosodic and vocal parameters. Additionally, different researchers can be assured of equal presentation of stimuli regardless of who conducts the assessment.

The ToM assessments also covered a suitably broad range of skills, such that the skills in the HFA cohort seem to have been reliably represented. Additionally, inclusion of two second-order tasks helped to elucidate the effects of task language on the assessment of ToM ability, which has important implications for future research. The battery of assessments used in the current study could be usefully employed by speech language therapists to determine a level of ToM ability and help to determine where to focus intervention.

The decision to conduct the most difficult ToM task (John & Mary story) at the beginning of the first session was problematic. As noted in the Methodology chapter, the decision to present this task first was made because the materials were anticipated to be a distraction. However, the participants were not given time to warm-up with easier tasks and therefore the fact that no child passed the John & Mary task could possibly be due to the timing of administration, at least for some of the children in the study. To prevent the materials from being a distraction, the examiner could have covered them with a cloth.

5.7.2.4 Skills on Assessment versus 'Real-Life' Skills

All skills were assessed in highly structured 1:1 settings with reduced auditory and visual distractions, using visual schedules to clearly delineate task expectations. These are modifications that suit children with HFA and were probably highly beneficial in the amount of task compliance observed in the participants. Results on the assessment measures are considered to have been strongly reflective of the actual level of ability for each participant within such highly structured environments. Yet, there was no assessment of ability within naturalistic settings, in the presence of multiple competing demands, or across a variety of communication partners.

5.7.3 Researcher-Specific Issues

5.7.3.1 Researcher Bias

This researcher was not blind to the status of the children, which could have influenced findings, although information about presence of AEP was not revealed until after the subjective judgments were made.

5.7.3.2 Researcher Accent

It is possible that some misunderstandings may have occurred due to the difference in the accent of the T2 examiner/author of the current study, an American English speaker (T1 testing was conducted by a speaker of Scottish English, therefore accent was not an issue). During the pilot testing, an error was made by one of the participants due to this difference. On the British Picture Vocabulary Scale, one of the named vocabulary items is 'waiter' which is pronounced in American English with the /ɾ/ phoneme, whilst in Scottish English it is pronounced as it is spelled, with the voiceless aspirated /t^h/ as the medial sound. Of the four pictured options, there is a waiter carrying food but there is also a picture of a man fishing who is up to his knees in the water; thus he is a 'wader.' A typically developing child made this error; whilst this examiner was careful from that point forward to pronounce the word with the /t^h/ phoneme, it is possible that this examiner's speech production may have been misleading in circumstances that were not readily apparent.

5.8 Future Directions

5.8.1 Language

A follow-up study with the same cohort of children with HFA would be an important investigation, given the paucity of longitudinal studies. As noted in Section 5.2.1.2, twenty-five percent of the HFA-T2 cohort showed a change in their profile of language skills over time. A follow-up study would help to determine if the children continue to show unpredictable individual trajectories. Moreover, such a study could provide evidence if, as a group, language growth continues into adolescence and early adulthood or if a plateau in skills occurs, as was found by Paul and Cohen (1984). Such a study might be a strong candidate for funding. Additionally, ethical approval was granted for the current study based on the need for longitudinal data. This rationale would still apply. In addition to the measures used in the current study, it would be beneficial to assess higher-order language skills, such as more in-depth semantic meaning as well as oral and written narrative abilities. As noted in the previous section on appropriate assessment methods, language sampling of discourse in a variety of settings and with different communication partners would also provide much needed information about the functional language abilities of adolescent children with HFA.

Another beneficial area of investigation for future research could compare the language and prosodic abilities across children with HFA and those with SLI. It would particularly useful to conduct an in-depth investigation of presence and level of deviance in grammatical and semantic abilities. Such an investigation would help to further clarify similarities and distinctions between HFA and SLI.

5.8.2 Prosody

The growth seen on the prosodic skills within structured tasks in the HFA-T2 cohort is encouraging. A follow-up study investigating prosodic ability at another point in time would indicate if skills continue to develop. However, the assessment measure would have to be adapted to include higher level tasks such as the comprehension of sarcasm in speech, as the ceiling effects evidenced in the PEPS-C show that assessment of prosody (for both children with HFA and typical development) needs to be broader to determine abilities on higher level skills. It would also be important to continue to assess prosodic abilities within both structured and unstructured tasks to provide further information about how these two facets operate. Assessment of expressive prosody should be expanded to include acoustic analysis to quantify and describe deficits more specifically. This would also allow examination of subtle changes in expressive prosody. Further exploration of the exaggerated versus monotonous type of AEP is also warranted; particularly whether or not there are other behavioural characteristics that might coincide with one type of AEP or the other. For example, some children with HFA have had a history of hyposensitivity to sensory input (including auditory stimuli), whilst others may present with a history of hypersensitivity to sensory input.

Additionally, assessment of expressive prosody should include analyses of speech in a variety of environments and contexts as well as across a variety of communication partners. Perhaps analyses of audio tapes from family interactions, educational settings with teachers and peers, as well as in structured contexts would provide a fuller picture of expressive prosodic ability.

5.8.3 Theory of Mind

A follow-up study of the ToM skills in this HFA cohort would be valuable. It could be conducted using the same ToM battery in this study for comparison over time. Such a study should add more higher-order tasks, such as the Happé Strange Stories (1994), to capture abilities that may have progressed beyond the battery used in the current study.

Further studies using the Wellman and Liu (2004) ToM scale with other groups of children with HFA are needed. It is essential that studies adhere uniformly to diagnostic criteria, however, as well as use identical ToM stories with the exact wording within tasks and equal complexity of grammar in the questions. Moreover, it is recommended that use of recorded narratives also be included to control for prosodic input, given the evidence from the current study that showed prosody and ToM skills interact. Only with such controls in place can cross-study comparisons be empirically beneficial.

Additionally, a study using the computerised version of the Wellman and Liu (2004) scale with typically developing British children would provide important normative data with which to compare the results of the children with HFA assessed in this and future studies. Additionally, if normative data were gathered using the ToM scale, as well as the PEPS-C, presence or absence of interaction between prosody and ToM in typically developing children could be identified.

5.9 Summary

In this chapter, results from the current study were compared to findings from previous studies. Theoretical assertions were made regarding relationships between language, prosody and ToM and implications for intervention were presented. Strengths and weaknesses of the study methodology were delineated. Finally, suggestions for future research were made. In the next chapter, concluding comments are presented.

6
Concluding Comments

This thesis has described continuity and change of language and prosody skills as well as their relationship to ToM in 24 children with HFA. The most encouraging results of this investigation concern the language and prosodic skill growth achieved by the group of children with HFA over an average of 2 ½ years. As a speech and language therapist, it is heartening to see results emerge that have some optimistic prognostic indications. Results showed that language skills have not become stagnant; rather these skills are continuing to develop in the same, although delayed, trajectory as children with typical development. Non-verbal cognitive skills are stable and within the same normal range as typical peers. Receptive and expressive prosodic abilities, as assessed within structured tasks, have closed the gap with children with typical development. The development of ToM skills is following the same progression as children with typical development who have been raised in a Western culture, although at a much later chronological age. These are findings that should encourage families of children with HFA and individuals who work with such children in educational and/or therapeutic settings; perhaps the modifications and individualised instruction and interventions aimed at recognising, emphasising and fostering strengths and individual interests whilst diversifying the curriculum to meet the learners' needs has benefited this growth and development.

Yet, as results have indicated, there are still many challenges faced by children with HFA. As a group, children with HFA show the most significant language impairment in their expressive abilities. The majority of these children continue to show combined receptive-and-expressive-language impairments. All of the children continue to have impaired pragmatic abilities.

While growth in prosodic ability within structured tasks was apparent, children with HFA continue to have difficulty understanding and using contrastive stress. Moreover, the overall improvement in prosody on the structured tasks was not mirrored in the spontaneous speech of children with atypical expressive prosody. Prosodic ability within structured tasks and within spontaneous speech was claimed to be somewhat dissociable, although scores on the expressive, structured tasks were able to predict the presence of AEP.

Children with HFA continue to show significant challenges with ToM, particularly on second-order tasks. Evidence from this study indicated that the language used in ToM tasks needs to be carefully considered and controlled. This study also showed the usefulness of a computerised adaptation for assessing ToM which may prove fruitful for use in future research and within clinical settings.

Evidence emerged that language, prosody and ToM are indeed related abilities. This study also made a theoretical assertion that these abilities begin to interact in the first year of life. Therefore, it was suggested that intervention may need to begin in infancy, with recommendations for incorporating facets of language, prosody and ToM. A key finding from this study provided the first empirical evidence that prosody and ToM interact meaningful, independent of language ability.

Children with HFA show both deviance and delay in all three areas, while the individual skills and deficits with language, prosody and ToM are markedly heterogeneous. As results of this study showed that skills are continuing to develop, assessment needs to be ongoing throughout the school-age years and should incorporate higher-level language and prosody tasks to adequately capture the full range of abilities and deficits. Interventions in the school-age years need to be individually designed and based on a comprehensive profile of skills and impairments.

Finally, a recommendation was made to conduct a follow-up study of this cohort of children with HFA to determine if the developmental progression of skills, seen in this study, extends into the adolescent years. This endeavour represents an opportunity to advance understanding of development of language, prosody and ToM in a closely defined group of adolescents with HFA and ascertain how skills and deficits impact on daily educational, vocational and life skills.

APPENDIX I

Queen Margaret University College
EDINBURGH

Royal Hospital for Sick Children
Edinburgh

Parent/Guardian of A Child With High-Functioning Autism
Information Sheet

A Study of Language Development in Children with High-Functioning Autism

Dear Parent/Guardian

We are contacting you as a research team from the Royal Hospital for Sick Children, Edinburgh and the Speech Sciences Research Department at Queen Margaret University College because your child participated in a research study with us 2 years ago. The information gained from that study was very helpful, as it was the first in-depth look at an aspect of communication known as 'prosody'. Prosody is present in everyone's speech and it makes an important contribution to communication, but very little research had been done on it.

Prosody includes aspects of your communication, such as the tone of voice that you use. It helps convey emotions and also separate out things that you say, which affects the meaning of what you say. Before the study, we suspected that in some way children with autism might have difficulties in both understanding this prosody and in using it, and that it caused them problems in their day to day communication.

Results of the study showed that the children with autism performed much poorer than the typically developing children. There was great variety in the performance of the children with autism, but all of them had difficulty with at least one aspect of prosody. Prosody was highly related to language skills, meaning that children with better language skills generally had better prosodic skills. In addition, the majority of the children with autism had difficulties in most aspects of language.

We have begun a related study which hopes to contribute information about language and prosody development over time in children with autism. To gather this information, we need to retest the children from the first study, so we can examine the growth and changes in their language skills.

Looking at language skills over time will give us very important information about how language develops and changes in children with autism. There has been little research done in this area, so your child will be helping us to change that. The same tests that were given to your child will be done again. In addition, there will be a new test given that can determine whether or not your child has acquired a skill called 'Theory of mind.' This refers to the ability for one person to understand that another person can have different feelings and thoughts from him or herself. It is quite important, especially for understanding and using language for social situations. We suspect that prosody and theory of mind are related skills.

Members of the research team work regularly with children with Autism and are well aware of the challenges that sometimes arise when trying to do research with the children. We will therefore be sensitive in thinking about how to help your child be most at ease with the research process, if you decide to take part.

This information sheet tells you what is involved. If you decide to take part, then where possible, we will tailor things to suit your child. You are their expert, so if you want to take part, we will discuss how best to do this with you. **If your child is 14 years or older, we would like to have him/her sign the consent form also.**

Here's what you and your child would be asked to do:

We will ask you and your child to come to Queen Margaret University College to the Speech Sciences Department on two different days. This can happen at a time that suits you. You and your child will need to be seen for about one and a half hours each time but this can be done in bits, with rest breaks, as we need them. If, at any time that you are there, your child wants to stop doing the interview, then that is fine and we will just stop. Also if brothers and sisters need to come too, we can arrange a room for you all. If you think that your child will find it difficult to sit still and pay attention, don't worry, as it will still be worth the visit.

We enclose some photographs to show you the rooms at the Queen Margaret University College, so that it gives you an idea of what your child will be asked to do. For example, in one task, a child is asked to listen to a recording of someone saying "chocolate biscuits and tea". This can sound like two things (chocolate-biscuits, tea) or three things (chocolate, biscuits, tea). Your child will be shown pictures of each combination and asked to say which one he or she heard. As with the first study, we can share the outcome of these findings with your own Speech and Language Therapist, as it may be something that they can make use of in their working with your child.

We are asking you to come to Queen Margaret University College, so that the interview with your child can be video taped as well as audio-recorded. The recordings will be used in the research project for analysis and full anonymity will be maintained. We prefer to be able to use video if possible, as it can give us helpful extra information about your child's communication. However, if you think it would only possible to conduct the interview in your home, and you can offer us that opportunity, please let us know.

We would also like to use samples of video recordings of some of the children participating in the project to train Health and Education professionals. In these recordings the child will not be named but their face would have to be visible. Specifically, the videos may be used by the research team in educational lectures or research presentations as illustrations of the social skills of the children as well as to highlight particular skills employed to engage and interact with the children. **You have the option to have your child participate or not, as well as to participate with or without video or audio recording.**

One of our research team members will contact you in a couple of weeks' time to see if you are interested in the study. In the meantime, if you have any queries, please contact Lianne Carroll on (0131) 317 3656.

If you would like to participate in the research but do not want to consent to video recording, then this would be fine as we will be seeking consent separately, for both video recording for the research analysis and also for training purposes.

Thank you very much for taking the time to read the information sheet.

Yours sincerely,

Dr Anne O'Hare,
Consultant Paediatrician

Centre Number:
Study Number:
Patient Identification Number for this trial:

CONSENT FORM for PARENTS/GUARDIANS

Title of Project: **A STUDY OF LANGUAGE DEVELOPMENT IN CHILDREN WITH HIGH-FUNCTIONING AUTISM**

Name of Researcher: Dr Anne O'Hare

Parent/Guardian: Please initial boxes

1. I confirm that I have read and understand the information sheet dated 12 October 2004 for the above study and have had the opportunity to ask questions.
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.
3. I understand that sections of any of my medical notes may be looked at by responsible individuals from [company name] or from regulatory authorities where it is relevant to my taking part in research. I give permission for these individuals to have access to my records.
4. I understand that confidentiality is always maintained and samples of my child's speech will be recorded anonymously and confidentially on audio tape recordings.
5. I understand that I have the choice of whether or not my child will be video recorded.

Please read the following and sign all that apply. If your child is age 14 and above, please explain the information to him/her and have him/her sign their own form, which is enclosed.

1. *I do / do not consent to my child .... participating in this research study to look at language development in children with High-Functioning Autism and being audio-recorded.
*(*please cross out the one that does not apply)*

Name of Parent/Guardian ....

Signature .... Date ....

Researcher Signature .... Date ....

2. ***I *do / do not consent to both audio and video recording of my child's participation.*** *(*please cross out the one that does not apply)*

Name of Parent/Guardian ....

Signature .... Date ....

Researcher Signature .... Date ....

3. ***I *do / do not consent to the use of *audio only / *audio and video recordings of my child's participation in training for professionals in Health and Education.***
(**please cross out the one that does not apply*) .

Name of Parent/Guardian ....

Signature .... Date ....

Researcher Signature .... Date ....

CONSENT FORM FOR STUDENTS 14 YEARS AND OLDER

Title of Project: **A STUDY OF LANGUAGE DEVELOPMENT IN CHILDREN WITH HIGH-FUNCTIONING AUTISM**

Name of Researcher: Dr Anne O'Hare

Student: Please initial boxes

6. I confirm that I have read, or my parent has read to me, and I understand the information sheet dated 12 October 2004 for the above study and have had the opportunity to ask questions. ☐

7. I understand that it is my choice to be in the study and that I can decide not to be in the study, at any time, without giving any reason, without my medical care or legal rights being affected. ☐

8. I understand that parts of any of my medical notes may be looked at by responsible individuals from [company name] or from regulatory authorities where it is relevant to my taking part in research. I give permission for these individuals to have access to my records. ☐

9. I understand that my privacy is always maintained and samples of my speech will be recorded without my name being used on audio tape recordings. ☐

10. I understand that I have the choice of whether or not I will be video recorded. ☐

For children aged 14 and above:

My parent/guardian has explained the research study to me and I *do/ do not consent to participating with my speech being recorded on audio tape.

(*please cross out the one that does not apply*).

Name ....

Signature ....

Date..

Researcher Signature ………………………   Date …………………………………………

2. ***I *do / do not consent to both audio and video taping of my participation.*** *(*please cross out the one that does not apply)*

Name …………………………………………………………

Signature ……………………………….   Date………………………………………….

Researcher Signature ……………………   Date …………………………………………..

3. ***I *do / do not consent to the use of *audio only / *audio and video recordings of my participation in training Health and Educational professionals.*** *(*please cross out the one that does not apply)*

Name …………………………………………………………...

Signature ……………………………………………   Date …………………………

Researcher Signature ………………………………   Date…………………………

APPENDIX III

Verbal Instructions by subtest
From PEPS-C Assessment User Guide
Version 1.6 manual (Peppé, McCann & Gibbon, 2005)

Turn-end type input

"You are going to hear the person on the computer say the names of some food. Sometimes she sounds as if she's asking you if you want some food, like this:"
"So you click on this picture" (demonstrate, clicking on picture on left).
"But if she sounds as if she is just telling you what she sees in the book, like this"
"then you click on this picture" (point to picture) say "Now it's your turn." (click)
"Do you think it sounded as if she was asking if you want some or telling you what she sees?" Encourage client to click on appropriate part of screen to select his answer.
"'And what about this one:" "asking or telling?"

Turn-end type output

"Now it's your turn to say some words like that.
You'll see pictures one by one on the screen.
If the picture shows somebody offering some food and a question mark, like this:" (indicate picture on screen),
"you say the food as though you were asking me if I want some. Like this:
Example 1 (tester models response): "'Carrots?' "
"If it shows someone looking at a picture of the food in a book, like this" (indicate screen) "say the food as though you were looking at it and just telling me what it is. Like this:. "'Tea.'"
"Now you try."

Affect Input

"We are going to find out what kind of food the person on the computer likes.
This picture shows tea" (indicate picture on screen) "She likes tea, so she says it like this"
"So you click on the happy face" Click mouse on happy face
"These are mushrooms; she doesn't like mushrooms so she says it like this"
"So you click on the sad face. Now you try."

Affect Output

"Now we are going to find out what kinds of food you like. I'm going to try and guess which ones you like by the way you say them. Pictures of food will come on the computer one by one, and, if you like that food, say the word as if you really like it, and then click on the smiley face. If you don't like it, say the word as though you don't really like that food, and then click the sad face."
"This one is tea. Try to say it so that I can guess whether you like it or not."

Intonation input

"You are going to listen to some noises and decide if they sound the same or different.
"These ones are the same; listen:"
"So you have to click on 'Same'" (tester models response by clicking on screen).
"These ones are different; listen:"
"So you have to click on 'Different.'
Now you try."

Intonation Output

"You are going to hear some words from the computer.
You need to try and copy each word making it sound *exactly* the same way as the computer says it.
I will do the first one; listen:"
"So the computer speaks and then you speak. Now you try."

Chunking Input

"We are going to hear the computer say some sentences or phrases.
You need to decide if it matches the pictures on this side best" (indicate left side of screen) "or this side best" (indicate right side of screen).
On this side," (indicate left) "we have pink-and-black and green socks.
On this side," (indicate right) "we have pink and black-and-green socks. Listen:"
"That's this one" (indicate left side) "so you have to click on it."
"This time we have some food" (Figure 19)
"On this side," (indicate left) "we have fish-fingers and fruit,
and on this side," (indicate right) "there's fish, fingers and fruit. Listen:"
"Which one do you think that was? (have client point to screen and say Now you do the rest."

Chunking Output

"Now it is your turn to say some words like that.
"You will see some pictures and I want you to tell me what you see.
So for this one you would say 'pink and green-and-black.'
""Now you try. Say what you see, and I'll guess what picture you see by the way you say it."

Focus Input

"Listen carefully. Earlier today, the person on the computer bought some socks. But when she got home, she realised she had forgotten to buy one colour. If she says this"
['I wanted blue and BLACK socks']"That means she forgot to buy the black ones, because she said 'I wanted blue and BLACK socks', so you click on black."
(Click on black patch).
"But if she says this:" ['I wanted BLUE and black socks']
"That means she forgot to buy the blue ones, because she said 'I wanted BLUE and black socks', so you click on blue." "Now you try."

<u>Focus Output</u>

"The cows and the sheep are playing football. This is the sheep team; they are all different colours. There is" (*indicate*) "a black sheep, a blue sheep, a green sheep, a red sheep and a white sheep. And this is the cow team: there is a black cow, a blue cow, a green cow, a red cow and a white cow. There is a commentator for this football match. He tells you what is happening during the game. But he is a bit silly and gets things wrong."

"He is going to tell you who he thinks has the ball and you have to correct him.

Click for sound: ['the green sheep has the ball']

To client say "You say 'No, the green COW has the ball' "Now you try."

<u>Prosody Input</u>

"Now we are going to do some more same and different noises, except this time you have to listen extra hard because they are longer.

These ones are the same:" "so you click on 'Same.'"

"These ones are different" "So you click on 'Different.' "Now we'll do some more."

<u>Prosody Output</u>

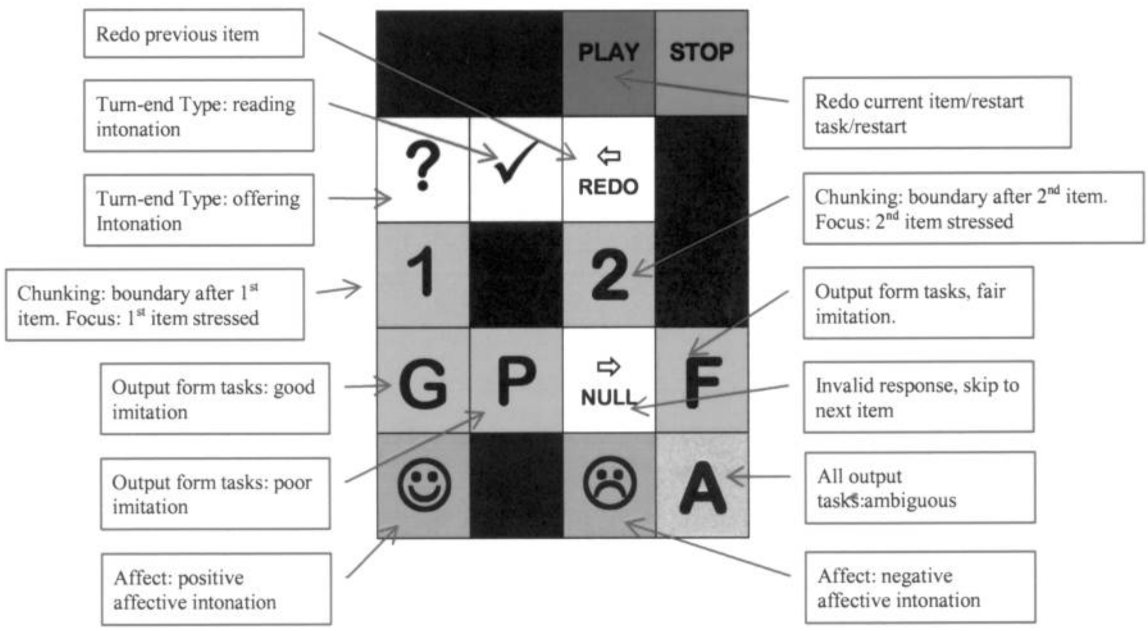
"Now we are going to copy some more words from the computer, except this time it is a few words at a time.

I will do the first one:" *Example 1:* click for sound ['green-and- red and black socks'];

"So the computer speaks and then you speak. Now you try. Remember to say it exactly the same way as the computer does."

Tester clicks for *Example 2:* [GREEN and blue socks], Client imitates stimulus.

Layout of keypad used by person administering assessment



APPENDIX IV

Theory of Mind Scale   Adapted from Wellman & Liu (2004)
University of Michigan
With permission from Wellman & Liu

Diverse Desire

Story: Here's Mr. Jones. It is his snack time. So, Mr. Jones wants a snack to eat. Here are two different snacks: a carrot (point) and a biscuit (point).

Own Desire: Which snack would **YOU like** best? Would you like a **carrot** (point) **or**…a **biscuit** (point) best?

___ If carrot: Well, that's a good choice, **BUT**…Mr. Jones **REALLY LIKES biscuits.** He doesn't like carrots. What he **likes best** are biscuits.

___ If biscuit: Well, that's a good choice, **BUT**…Mr. Jones **REALLY LIKES carrots** (don't point). He doesn't like biscuits. What he **likes best** are carrots.

Question: So, now it's time to eat. Mr. Jones can only choose **one** snack, **just one**. Which snack will Mr. Jones (point to Mr. Jones) **choose**?…A carrot or…a biscuit?

___ carrot ___ biscuit

Theory of Mind Scale   Adapted from Wellman & Liu (2004)
University of Michigan
With permission from Wellman & Liu

Diverse Belief

Story: Here's Linda (Linda wants to find her cat. Her cat might be hiding in the bushes (point) or…it might be hiding in the garage (point).

Own Belief: Where do **YOU think** the cat is? **In the bushes or…in the garage**?

___ If bushes: Well, that's a good idea, **BUT**…Linda **THINKS** her cat is **in the garage** (don't point). She **thinks** her cat is in the garage.

___ If garage: Well, that's a good idea, **BUT**…Linda **THINKS** her cat is **in the bushes** (don't point). She **thinks** her cat is in the bushes.

Question: So…where will Linda (point to Linda) **look** for her cat?…In the bushes or…in the garage?

___ bushes ___ garage

Theory of Mind Scale Adapted from Wellman & Liu (2004)
University of Michigan
With permission from Wellman & Liu

<u>Knowledge Access (X)</u>

Experimenter: Here's a drawer

Question to child: What do you think is inside the drawer

Experimenter: Let's see…it's really **a DOG** inside!

Post-view Question: Okay…what is in the drawer? _______________

Experimenter: Polly has **never ever seen** inside this drawer.
Now here comes Polly.

Question: So…does Polly **KNOW** what is in the drawer?

___ yes ___ no

Did Polly **see** inside this drawer?

___ yes ___ no

Theory of Mind Scale Adapted from Wellman & Liu (2004)
University of Michigan
With permission from Wellman & Liu

Contents False-Belief (X)

Experimenter: Here is a Plaster box.

Question to child: What do you think is inside the Plaster box? ______________

Experimenter: (Let's see…it's really **a PIG** inside!

Post-view Question: Okay…what is in the box? ______________
(If child makes an error here, show contents inside again until child gets this question correct)

Experimenter: Peter has **never ever seen** inside this Plaster box. Now here comes Peter.

Question: So…what does Peter **THINK** is in the box? Plasters or a Pig?

___ Plasters ___ Pig

Did Peter **see** inside this box?

___ yes ___ no

Theory of Mind Scale Adapted from Wellman & Liu (2004)
University of Michigan
With permission from Wellman & Liu

Hidden Emotion

Experimenter: Now, I'm going to tell you a story about a boy. In this story, the boy might feel happy, he might feel sad , or He might be not feel happy or sad, just OK

Can you point to the face that is:

___ Sad?
___ OK?
___ Happy?

Experimenter: Okay, now about the story: After I've finished the story, I'm going to ask you about how the boy really feels, inside, **AND** how he looks on his face. How he **really feels inside** may be the same as how he **looks on his face** or they may be different.

Experimenter: This story is about Matt Matt's aunt just got back from a trip. She promised that she would buy Matt a toy car. **But**, she got Matt a book instead. Matt **doesn't like books**. What Matt really wants is a toy car. **But**...Matt has to **hide how he feels**, because if his aunt knows his real feelings, she'll never buy him anything again.

Memory Check: What did Matt's aunt buy for him?

____

What will Matt's aunt do, if she knows how Matt really feels?

____

Question: So...how did Matt **really feel**, when his aunt gave him the book—Happy, Sad, or Okay?

___ Happy ___ Sad ___ Okay

How did Matt **try to look** on his face, when his aunt gave him the book—Happy, Sad, or Okay?

___ Happy ___ Sad ___ Okay

APPENDIX V

Chocolate Story

This is Granddad with Anne and Simon. He has given them some chocolate to share.
Granddad says, "Go and put the chocolate away.
You can have some when Mum says so."

The children go into the kitchen and put the chocolate in the fridge.
Then they go out to play.

A little later, Simon comes in for a glass of water.
He goes to the fridge and sees the chocolate.
He wants to keep the chocolate all to himself, so he takes the chocolate out of the fridge and puts it into his bag.

Oh, look. Anne is playing by the window. She can see everything Simon is doing! She sees him put the chocolate in his bag! Simon is so busy hiding the chocolate that he doesn't see Anne watching him!

Later Mum calls Simon and Anne into the kitchen.
She says they can have some of the chocolate.

Where does Simon think Anne will look for the chocolate?

Why does Simon think that?

Where is the chocolate really?

Where was the chocolate first of all?

John & Mary Story

This is John and this is Mary. They live in this village.
Here is the park and here is the church.

Memory check questions (Which is John? Which is Mary?)

Here they are in the park. Along comes the ice-cream man.

John would like to buy an ice-cream but he has left his money at home. He is very sad.

"Don't worry" says the ice-cream man, "you can go home and get your money and buy some ice-cream later. I'll be here in the park all afternoon."
"Oh good" says John, "I'll be back in the afternoon to buy some ice-cream."

Memory check question
(Where did the ice-cream man say to John that he would be all afternoon?)

So, John goes home. He lives in this house. Now the ice-cream man says "I am going to drive my van to the church to see if I can sell my ice-creams outside there."

Memory Check questions
(Where did the ice-cream man say he was going? Did John hear that?)

The ice-cream man drives over to the church. On his way, he passes John's house. John sees him and says, "Where are you going?" The ice-cream man says, "I'm going to sell some ice-cream outside the church." So, off he drives to the church.

Memory check questions
(Where did the ice-cream man tell John he was going?
Does Mary know that the ice-cream man has talked to John?)

Now Mary goes home. She lives in this house. Then she goes to John's house. Mary knocks on the door at John's house. She says, "Is John here?"
"No," says his mother, "he's gone out to buy an ice-cream."

Test question 1) Where does Mary think John has gone to buy an ice-cream?

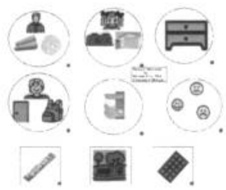
Test question 2) Why?

Memory check questions
(Where did John really go to buy his ice-cream?
Where was the ice-cream man at the beginning?)

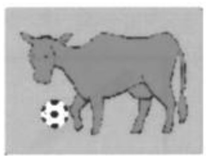
A) Diverse Desire	Which snack would **YOU like** best? Would you like a **carrot or** ...a biscuit best?	carrot biscuit	
	Which snack will Mr. Jones **choose**? A carrot or a biscuit?	carrot biscuit	
B)DiverseBelief	Where do **YOU think** the cat is? **In the bushes or…in the garage**?	bushes garage	
aka diverse beliefs	So… where will Linda look for her cat? In the bushes or…in the garage?	bushes garage	
C)Knowledge Access	Preview question: What do you think is inside the drawer?		
	Postview question: What is in the drawer?		
	So…does Polly **KNOW** what is in the drawer?	yes no	
	Did Polly **see** inside this drawer?	yes no	
D) Contents False-Belief	What do you think is inside the plaster box?		
	Postview question: Okay, what is in the box?		
	So….what does Peter **THINK** is in the box? Plasters or a Pig?	Plasters Pig	
	Did Peter see inside this box?	yes no	
E)Hidden Emotion	Real apparent emotion		
a. training	Can you point to the face that is:	Sad? OK? Happy?	
b. Memory Check	What did Matt's aunt buy for him?	book car other	
c. Questions	What will Matt's aunt do, if she knows how Matt really feels?		
	How did Matt feel when his aunt gave him the book?	happy sad ok	
	How did Matt try to look on his face when his aunt gave him the book?	happy sad ok	
d. score	Is II happier than I ?		
	Pass A B C D E	**Total /5**	

Task:	Prompt:	Response:	+ / -	
Smarties	What do you think is inside?	**Smarties**/ DK/		
	Look, what is really inside the smarties tube?	**Pencil/** DK		
	What will Amy think is in the tube?	**Smarties**/Pencil/DK/		
	What is really in the tube?	**Pencil**/smarties/DK/		
		Smarties	P	F
Task:	**Prompt:**	**Response:**	**+ / -**	
Chocolate story	Where does Simon think Anne will look for the chocolate?	**fridge** bag DK		
	Why does Simon think that?		0 1	2
	Where is the chocolate really?	fridge **bag** DK		
	Where was the chocolate first of all?	**fridge** bag DK		
		Chocolate story	P	F
Task:	**Prompt:**	**Response:**	**+ / -**	
John & Mary	Which is John? Which is Mary?			
	Where did the ice-cream man say to John that he would be all afternoon?	**park**/DK/		
	Where did the ice-cream man say he was going?	**church**/park/DK		
	Did John hear that?	**no**/yes/DK/		
	Where did the ice-cream man tell John he was going?	**church**/park/DK		
	Does Mary know that the ice-cream man has talked to John?	**no**/yes/DK		
	Where does Mary think John has gone to buy an ice-cream?	**park**/church/DK/		
Why?			0 1	2
	Where did John really go to buy his ice-cream?	**church**/park/DK/		
	Where was the ice-cream man in the beginning?	**park**/church/DK/		
		John & Mary	P	F

John and Mary Story 

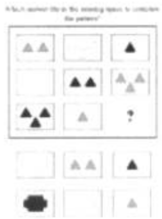
Computer stories 

Name pictures 

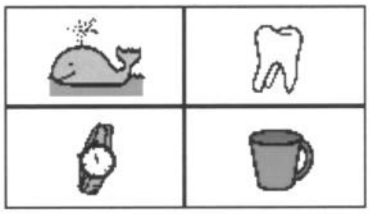
Computer questions 

Finished for today……well done! 

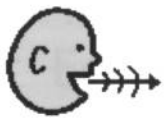
Designs



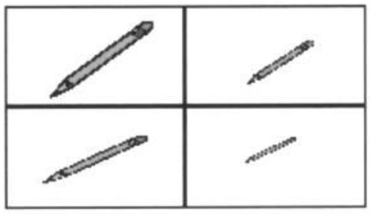
Point to pictures



Answer questions



Pointing to pictures



Finished for today……well done!

Queen Margaret University College

This is to say thank you to

For help in 2005 with a QMUC research project in conjunction with University of Edinburgh, with funding generously provided by the Sick Kids Friends Foundation.

Lianne Carroll PhD Research Student
Speech and Language Sciences.
Queen Margaret University College.



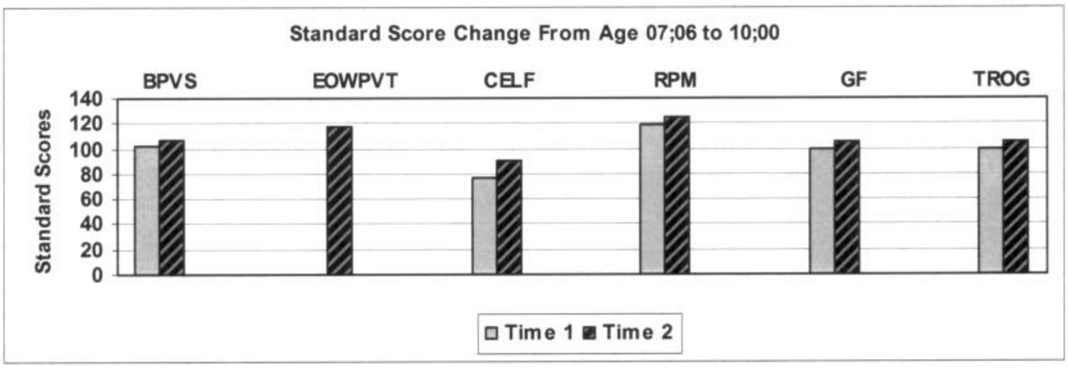

01H0706 - Male

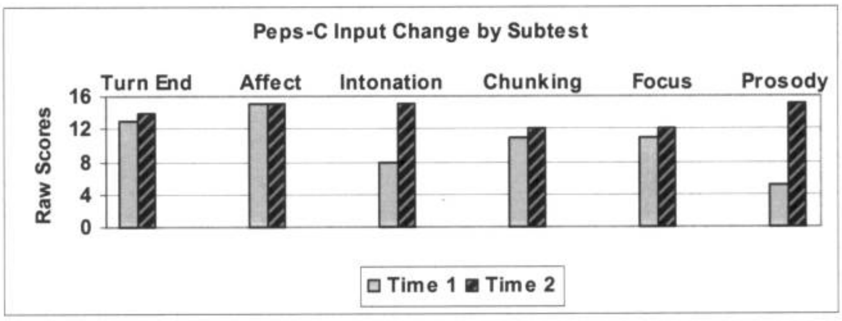
	Time 1	Time 2	Time Elapsed 2;06 yrs
Chronological Age	7;06	10;00	

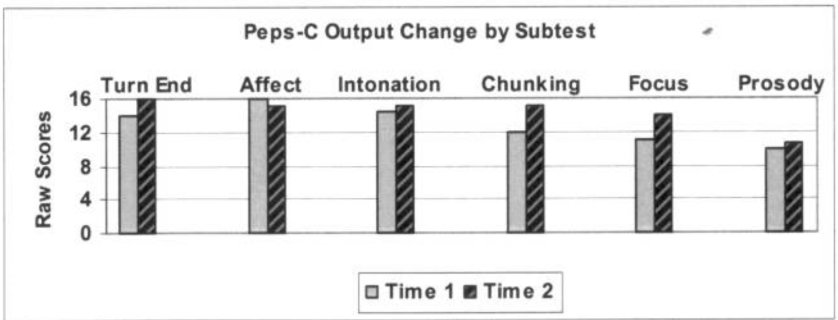
Language	Standard Score	
British Picture Vocabulary Scale (BPVS)	102	107
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	117
Clinical Evaluation of Language Fundamentals (CELF)	77	91
Raven's Progressive Matrices (RPM)	119	125
Goldman-Fristoe Test of Articulation (GF)	100	105
Test for Reception of Grammar (TROG)	99	106
Children's Communication Checklist (CCC & CCC-2)	(CCC 138)	31 General Communication Composite -14 Social Interaction Deviance Composite

Prosody	Time 1		Time 2	
Subjective Judgment	Typical Prosody		Typical Prosody	
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT
Turn end	13	14	14	16
Affect	15	16	15	15
Intonation	8	14.5	15	15
Chunking	11	12	12	15
Focus	11	11	12	14
Prosody	5	10	15	10.5
PEPS-C Total Score	Time 1	140.5	Time 2	168.5

Theory of Mind	
Smarties	P
Wellman Scale	5
Chocolate Story	P
John & Mary Story	F
ToM Aggregate	7





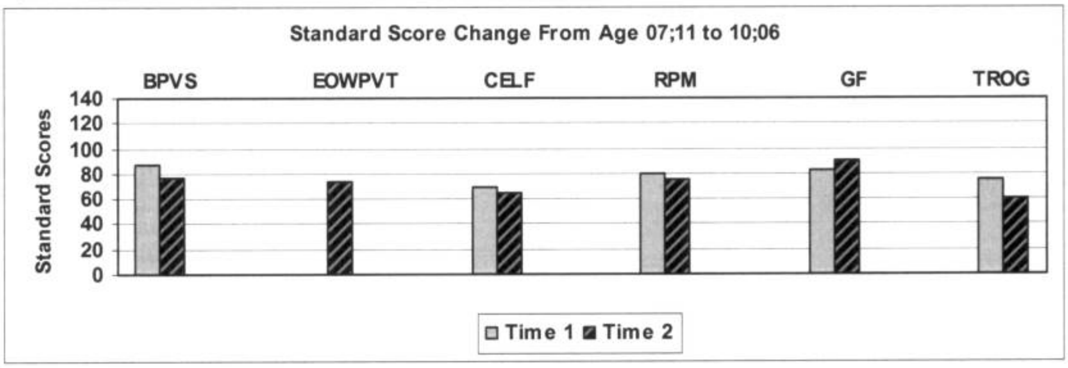


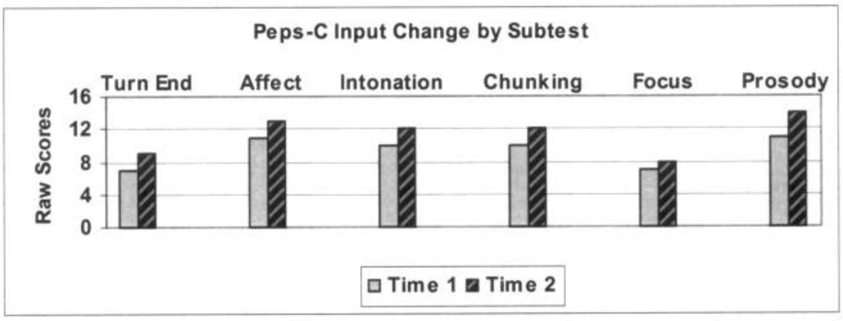
02H0711 - Male | Time 1: 7;11 | Time 2: 10;06 | Time Elapsed 2;06 yrs

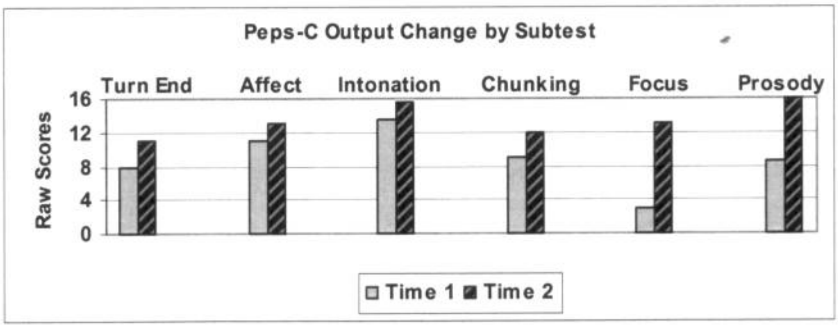
Chronological Age: Time 1 7;11, Time 2 10;06

Language	Time 1 Standard Score	Time 2 Standard Score
British Picture Vocabulary Scale (BPVS)	87	77
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	74
Clinical Evaluation of Language Fundamentals (CELF)	69	64
Raven's Progressive Matrices (RPM)	80	75
Goldman-Fristoe Test of Articulation (GF)	83	90
Test for Reception of Grammar (TROG)	75	60
Children's Communication Checklist (CCC & CCC-2)	(CCC 113)	15 General Communication Composite; 1 Social Interaction Deviance Composite

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical Prosody		Atypical Prosody*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	P
Turn end	7	8	9	11	Wellman Scale	4
Affect	11	11	13	13	Chocolate Story	F
Intonation	10	13.5	12	15.5	John & Mary Story	F
Chunking	10	9	12	12	ToM Aggregate	5
Focus	7	3	8	13		
Prosody	11	8.5	14	16		
PEPS-C Total Score	Time 1 109		Time 2 148.5		* exaggerated prosody	



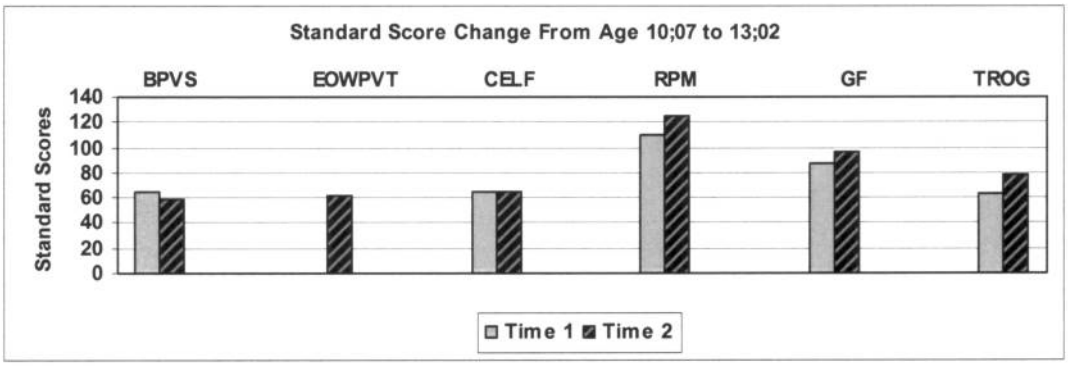


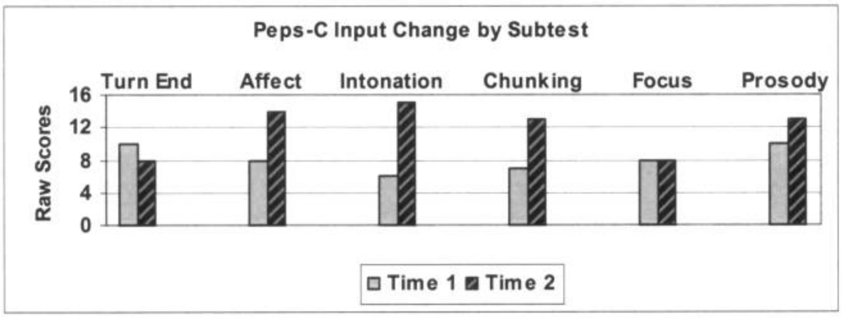


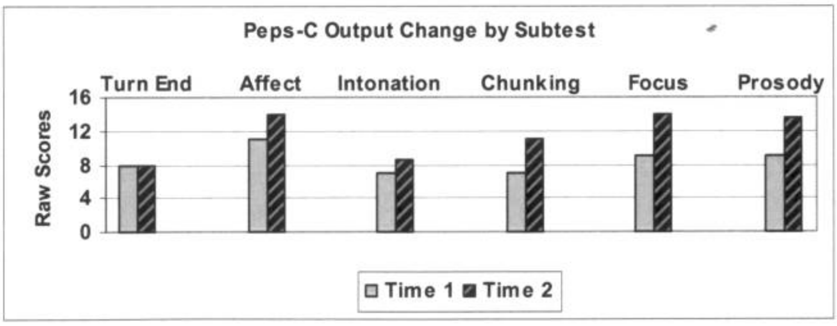
04H1007 - Female	Time 1	Time 2	Time Elapsed 2;06 yrs
Chronological Age	10;07	13;02	

Language	Standard Score		
British Picture Vocabulary Scale (BPVS)	65	59	
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	62	
Clinical Evaluation of Language Fundamentals (CELF)	64	64	
Raven's Progressive Matrices (RPM)	110	125	
Goldman-Fristoe Test of Articulation (GF)	87	96	
Test for Reception of Grammar (TROG)	63	78	
Children's Communication Checklist (CCC & CCC-2)	(CCC 106)	47 General Communication Composite -10 Social Interaction Deviance Composite	

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical Prosody		Atypical Prosody*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	F
Turn end	10	8	8	8	Wellman Scale	2
Affect	8	11	14	14	Chocolate Story	F
Intonation	6	7	15	8.5	John & Mary Story	F
Chunking	7	7	13	11	ToM Aggregate	2
Focus	8	9	8	14		
Prosody	10	9	13	13.5		
PEPS-C Total Score	Time 1	100	Time 2	140	* monotonous prosody	





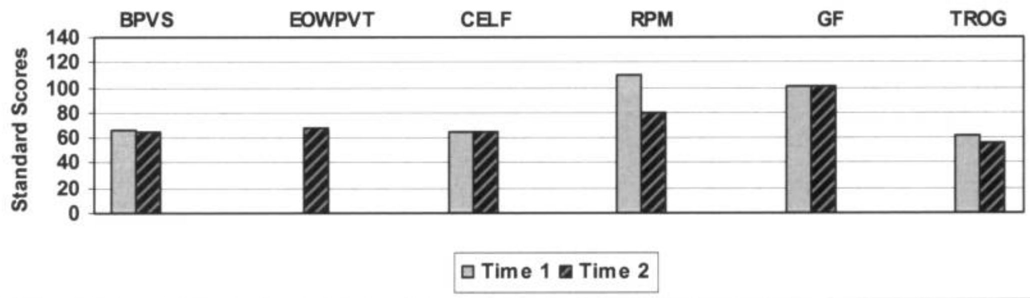


05H0903 - Female	Time 1	Time 2	Time Elapsed 2;07 yrs
Chronological Age	09;03	11;10	

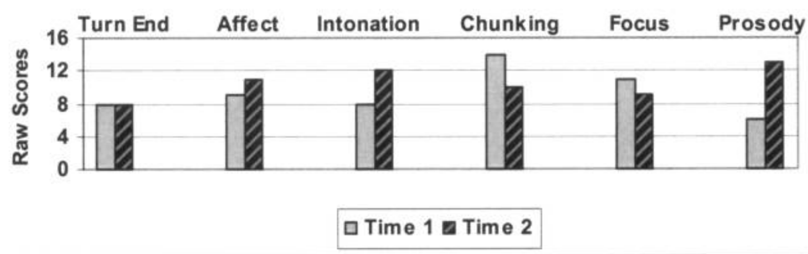
Language	Standard Score		
British Picture Vocabulary Scale (BPVS)	66	64	
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	67	
Clinical Evaluation of Language Fundamentals (CELF)	65	65	
Raven's Progressive Matrices (RPM)	110	80	
Goldman-Fristoe Test of Articulation (GF)	101	101	
Test for Reception of Grammar (TROG)	62	55	
Children's Communication Checklist (CCC & CCC-2)	(CCC 114)		N/A General Communication Composite N/A Social Interaction Deviance Composite

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical Prosody		Atypical Prosody*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	F
Turn end	8	9	8	8	Wellman Scale	1
Affect	9	9	11	6	Chocolate Story	F
Intonation	8	12.5	12	4.5	John & Mary Story	F
Chunking	14	10	10	10	ToM Aggregate	1
Focus	11	7	9	9		
Prosody	6	10	13	6		
PEPS-C Total Score	Time 1	113.5	Time 2	106.5	* monotonous prosody	

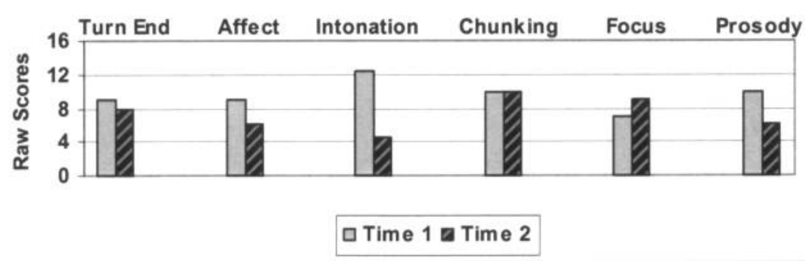
Standard Score Change From Age 09;03 to 11;10



Peps-C Input Change by Subtest



Peps-C Output Change by Subtest

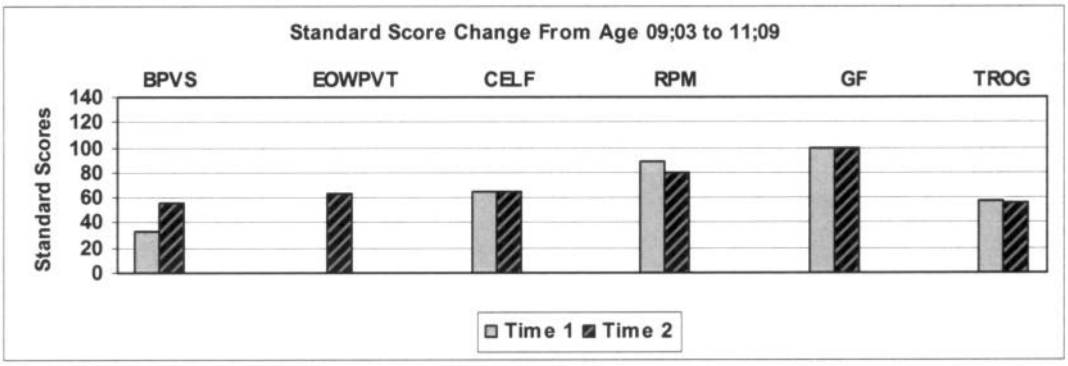


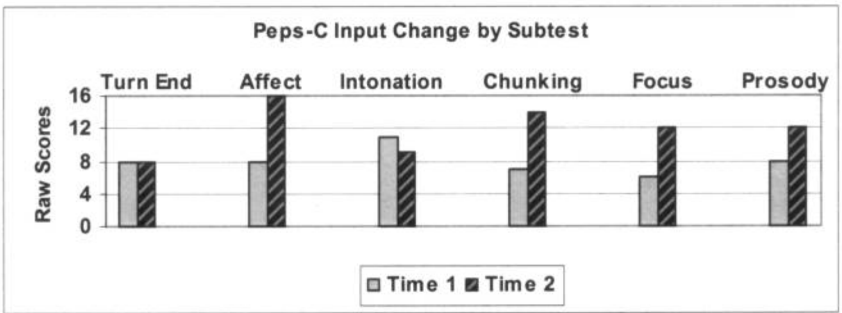
06H0903 - Male

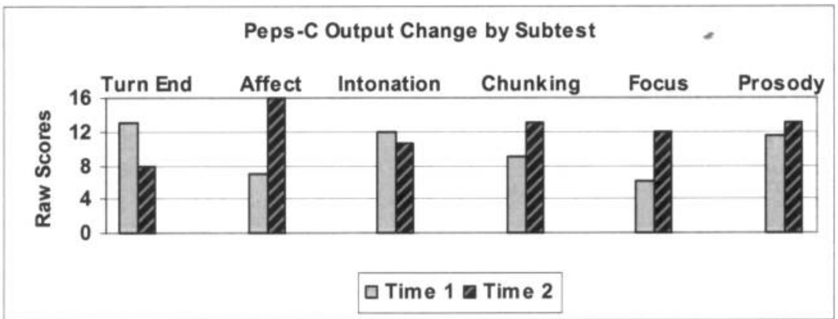
	Time 1	Time 2	Time Elapsed 2;06 yrs
Chronological Age	09;03	11;09	

Language	Standard Score		
British Picture Vocabulary Scale (BPVS)	33	55	
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	63	
Clinical Evaluation of Language Fundamentals (CELF)	65	65	
Raven's Progressive Matrices (RPM)	89	80	
Goldman-Fristoe Test of Articulation (GF)	100	99	
Test for Reception of Grammar (TROG)	57	55	
Children's Communication Checklist (CCC & CCC-2)	(CCC 128)	14 General Communication Composite 2 Social Interaction Deviance Composite	

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Typical Prosody		Typical Prosody			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	F
Turn end	8	13	8	8	Wellman Scale	2
Affect	8	7	16	16	Chocolate Story	F
Intonation	11	12	9	10.5	John & Mary Story	F
Chunking	7	9	14	13	ToM Aggregate	2
Focus	6	6	12	12		
Prosody	8	11.5	12	13		
PEPS-C Total Score	Time 1 106.5		Time 2 143.5			

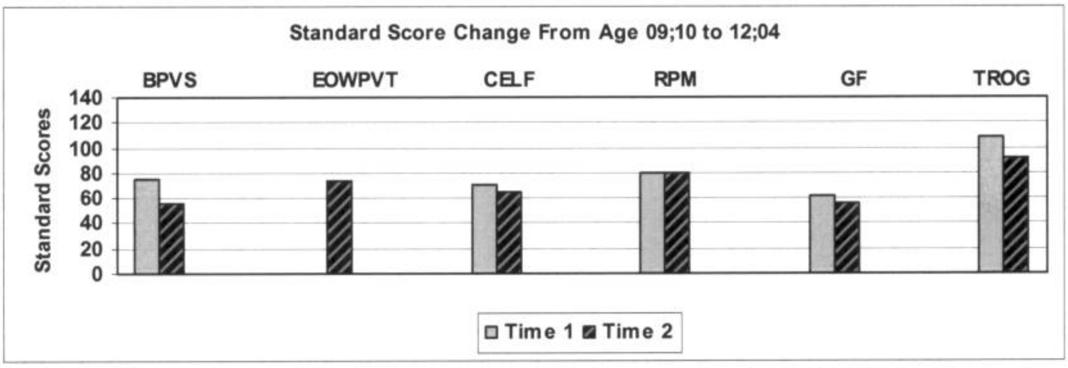


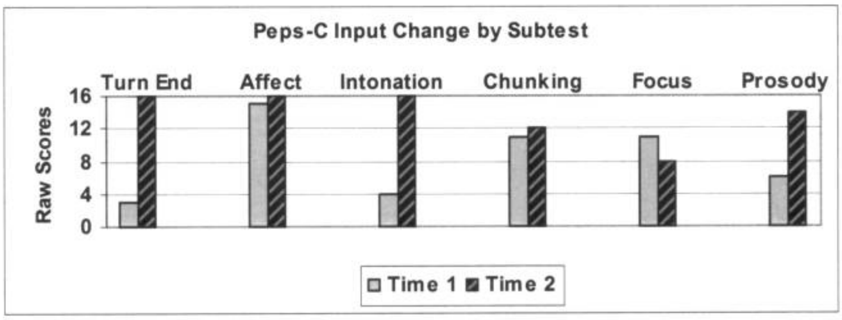


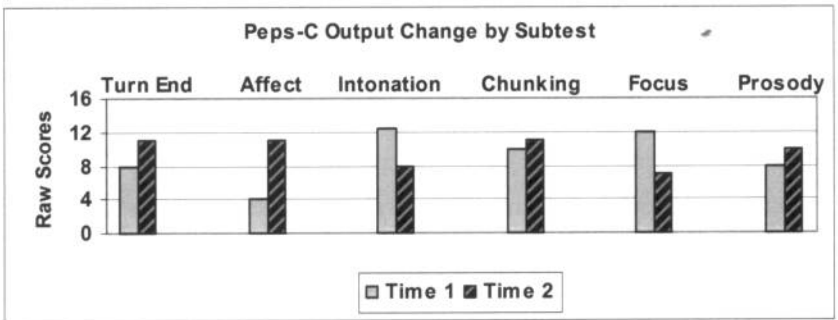


07H0910 - Male	Chronological Age	Time 1 09;10	Time 2 12;04	Time Elapsed 2;06 yrs
Language		Standard Score		
British Picture Vocabulary Scale (BPVS)		75	55	
Expressive One-Word Picture Vocabulary Test (EOWPVT)		~	74	
Clinical Evaluation of Language Fundamentals (CELF)		71	64	
Raven's Progressive Matrices (RPM)		80	80	
Goldman-Fristoe Test of Articulation (GF)		61	55	
Test for Reception of Grammar (TROG)		109	92	
Children's Communication Checklist (CCC & CCC-2)		(CCC 149)		11 General Communication Composite -3 Social Interaction Deviance Composite

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical Prosody		Atypical Prosody*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	P
Turn end	3	8	16	11	Wellman Scale	5
Affect	15	4	16	11	Chocolate Story	P
Intonation	4	12.5	16	8	John & Mary Story	F
Chunking	11	10	12	11	ToM Aggregate	7
Focus	11	12	8	7		
Prosody	6	8	14	10		
PEPS-C Total Score	Time 1 104		Time 2 140		* monotonous prosody	



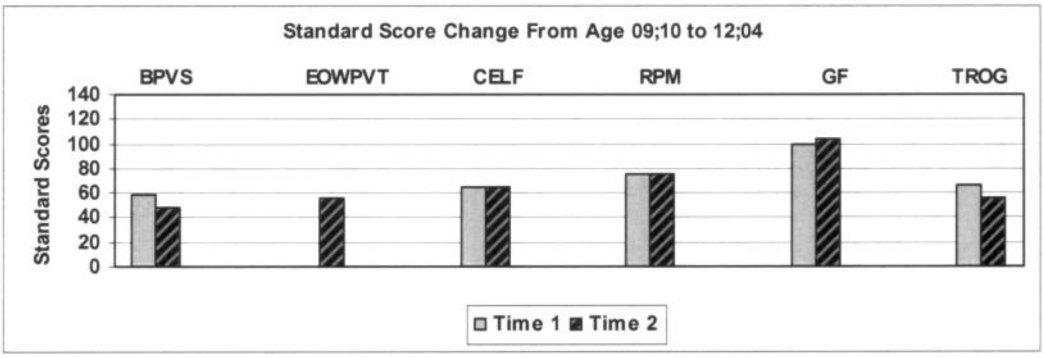


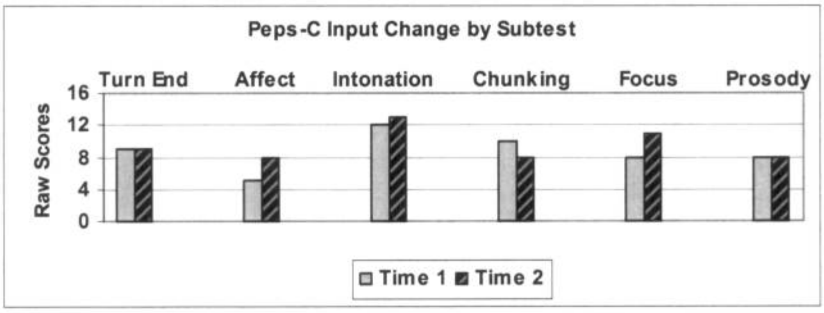


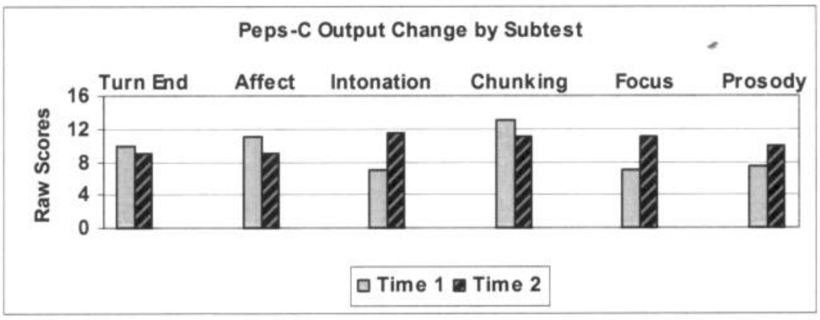
08H0910 - Male	Time 1	Time 2	Time Elapsed 2;06 yrs
Chronological Age	09;10	12;04	

Language	Standard Score		
British Picture Vocabulary Scale (BPVS)	58	48	
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	56	
Clinical Evaluation of Language Fundamentals (CELF)	65	64	
Raven's Progressive Matrices (RPM)	75	75	
Goldman-Fristoe Test of Articulation (GF)	100	104	
Test for Reception of Grammar (TROG)	66	55	
Children's Communication Checklist (CCC & CCC-2)	(CCC 116)	6 General Communication Composite 2 Social Interaction Deviance Composite	

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical Prosody		Atypical Prosody*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	F
Turn end	9	10	9	9	Wellman Scale	4
Affect	5	11	8	9	Chocolate Story	F
Intonation	12	7	13	11.5	John & Mary Story	F
Chunking	10	13	8	11	ToM Aggregate	4
Focus	8	7	11	11		
Prosody	8	7.5	8	10		
PEPS-C Total Score	Time 1 107.5		Time 2 118.5		* exaggerated prosody	



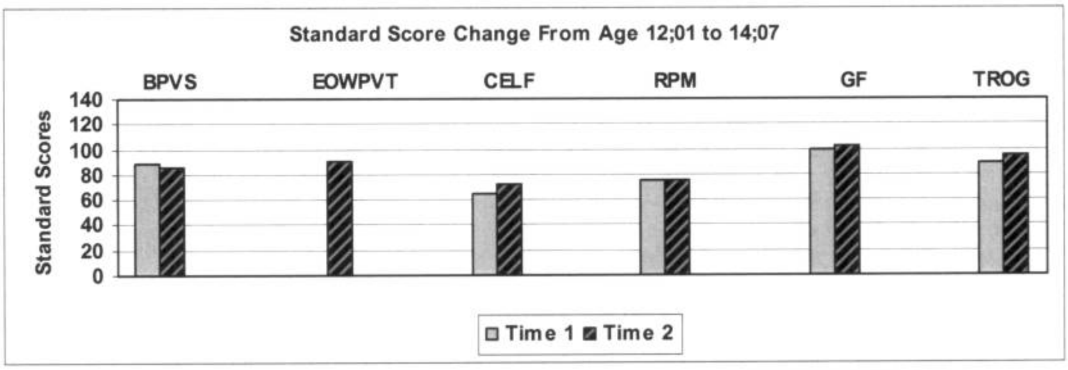


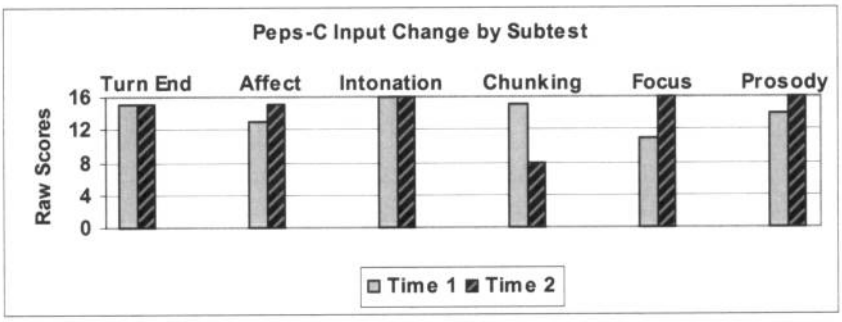


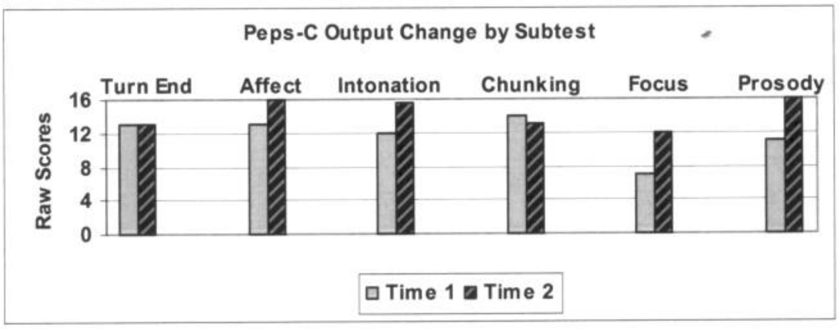
09H1201 - Male	Time 1	Time 2	Time Elapsed 2;05 yrs
Chronological Age	12;01	14;07	

Language	Standard Score		
British Picture Vocabulary Scale (BPVS)	89	86	
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	90	
Clinical Evaluation of Language Fundamentals (CELF)	64	72	
Raven's Progressive Matrices (RPM)	75	75	
Goldman-Fristoe Test of Articulation (GF)	99	103	
Test for Reception of Grammar (TROG)	89	95	
Children's Communication Checklist (CCC & CCC-2)	(CCC 111)		14 General Communication Composite -10 Social Interaction Deviance Composite

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Typical Prosody		Typical Prosody			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	P
Turn end	15	13	15	13	Wellman Scale	5
Affect	13	13	15	16	Chocolate Story	F
Intonation	16	12	16	15.5	John & Mary Story	F
Chunking	15	14	8	13	ToM Aggregate	6
Focus	11	7	16	12		
Prosody	14	11	16	16		
PEPS-C Total Score	Time 1 154		Time 2 171.5			





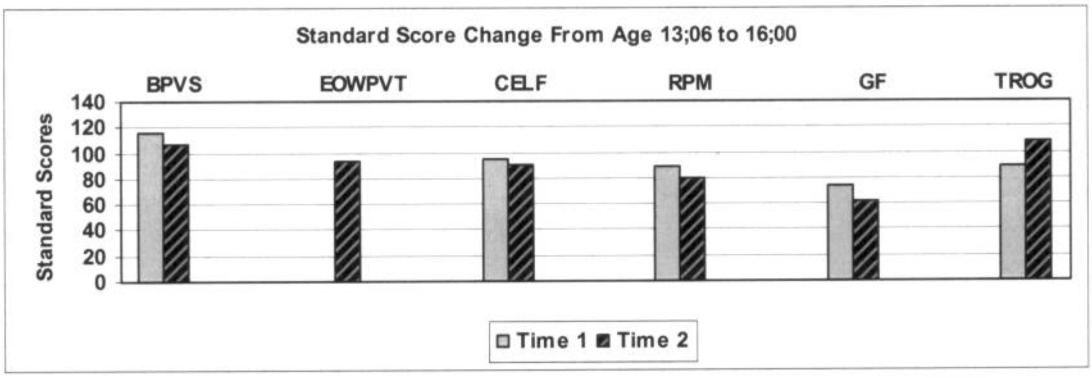


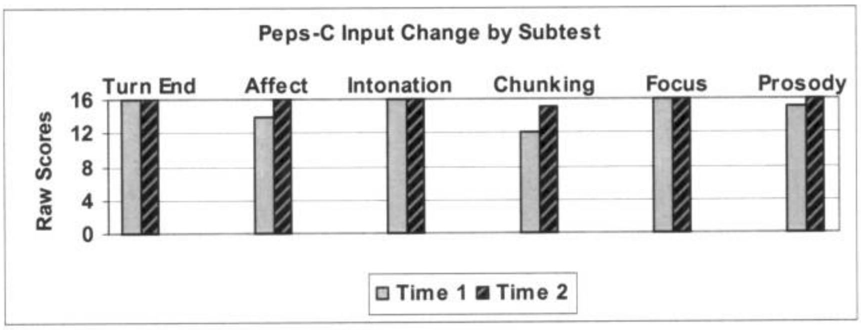
10H1306 - Male | Time 1 | Time 2 | Time Elapsed 2;05 yrs
Chronological Age | 13;06 | 16;00

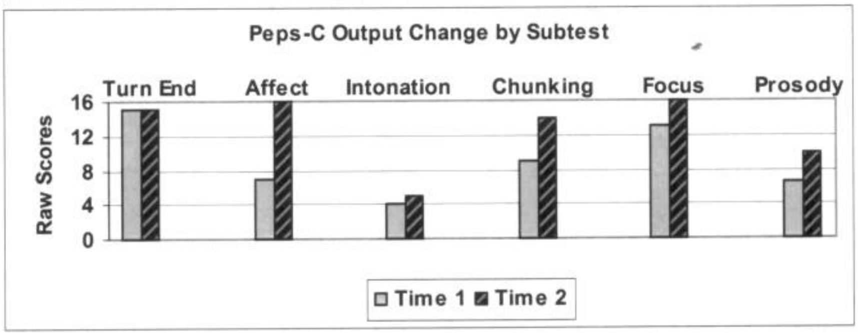
Language	Time 1	Time 2
	Standard Score	
British Picture Vocabulary Scale (BPVS)	116	107
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	94
Clinical Evaluation of Language Fundamentals (CELF)	95	90
Raven's Progressive Matrices (RPM)	89	80
Goldman-Fristoe Test of Articulation (GF)	74	62
Test for Reception of Grammar (TROG)	89	109
Children's Communication Checklist (CCC & CCC-2)	(CCC 134)	8 General Communication Composite -8 Social Interaction Deviance Composite

Prosody	Time 1		Time 2	
Subjective Judgment	Typical Prosody		Typical Prosody	
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT
Turn end	16	15	16	15
Affect	14	7	16	16
Intonation	16	4	16	5
Chunking	12	9	15	14
Focus	16	13	16	16
Prosody	15	6.5	16	10
PEPS-C Total Score	Time 1	143.5	Time 2	171

Theory of Mind	
Smarties	P
Wellman Scale	4
Chocolate Story	F
John & Mary Story	F
ToM Aggregate	5



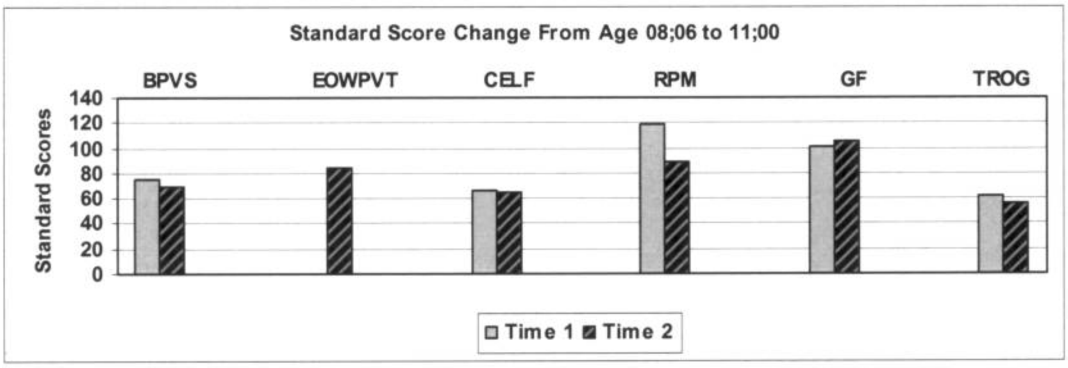


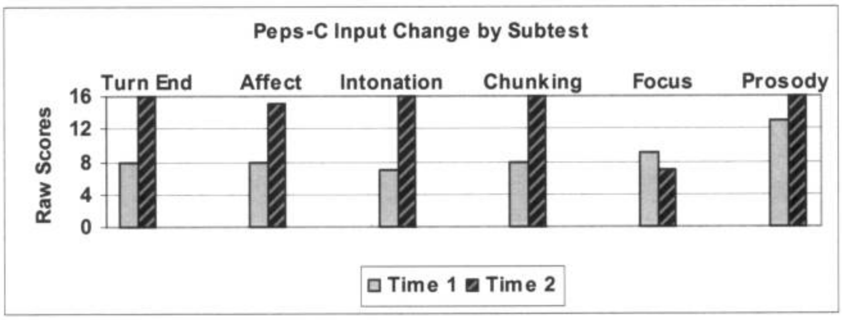


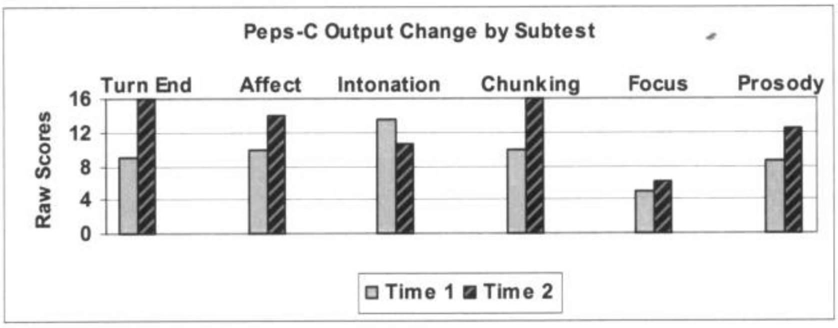
12H0806 - Female | | Time 1 | Time 2 | Time Elapsed 2;05 yrs

	Time 1	Time 2	
Chronological Age	8;06	11;00	
Language	**Standard Score**		
British Picture Vocabulary Scale (BPVS)	76	70	
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	84	
Clinical Evaluation of Language Fundamentals (CELF)	66	65	
Raven's Progressive Matrices (RPM)	119	89	
Goldman-Fristoe Test of Articulation (GF)	101	105	
Test for Reception of Grammar (TROG)	62	55	
Children's Communication Checklist (CCC & CCC-2)	(CCC 122)	14 General Communication Composite 5 Social Interaction Deviance Composite	

Prosody	**Time 1**		**Time 2**		**Theory of Mind**	
Subjective Judgment	Atypical Prosody		Atypical Prosody*			
Peps-C Subtests	**INPUT**	**OUTPUT**	**INPUT**	**OUTPUT**	**Smarties**	F
Turn end	8	9	16	16	**Wellman Scale**	1
Affect	8	10	15	14	**Chocolate Story**	F
Intonation	7	13.5	16	10.5	**John & Mary Story**	F
Chunking	8	10	16	16	**ToM Aggregate**	1
Focus	9	5	7	6		
Prosody	13	8.5	16	12.5		
PEPS-C Total Score	Time 1	109	Time 2	161	* exaggerated prosody	



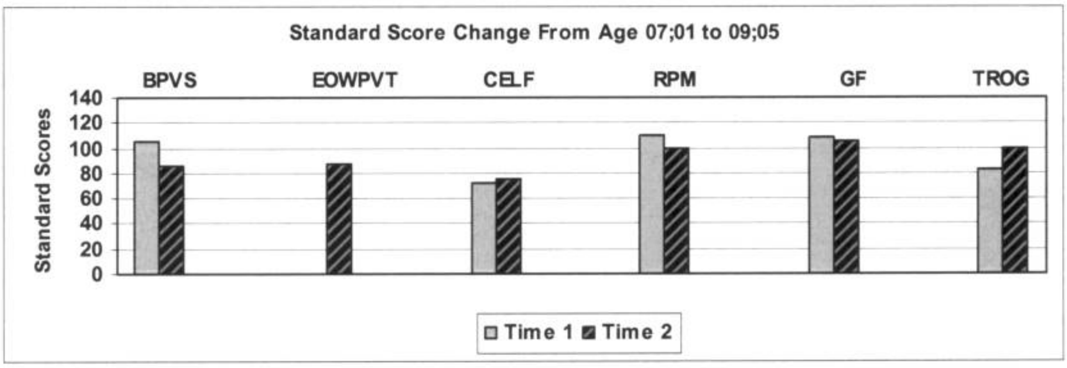


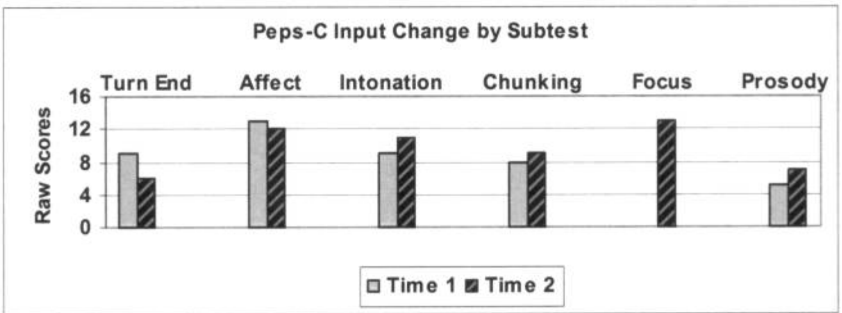


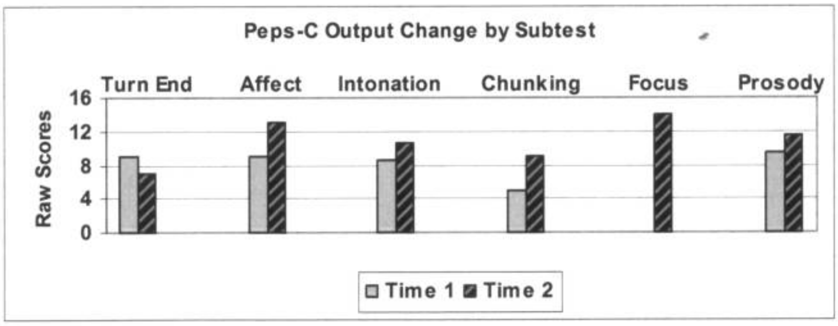
14H0701 - Male	Time 1	Time 2	Time Elapsed 2;04 yrs
Chronological Age	07;01	09;05	

Language	Standard Score		
British Picture Vocabulary Scale (BPVS)	105	86	
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	88	
Clinical Evaluation of Language Fundamentals (CELF)	73	76	
Raven's Progressive Matrices (RPM)	110	100	
Goldman-Fristoe Test of Articulation (GF)	109	106	
Test for Reception of Grammar (TROG)	83	99	
Children's Communication Checklist (CCC & CCC-2)	(CCC 103)		36 General Communication Composite -15 Social Interaction Deviance Composite

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical Prosody		Atypical Prosody*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	P
Turn end	9	9	6	7	Wellman Scale	4
Affect	13	9	12	13	Chocolate Story	P
Intonation	9	8.5	11	10.5	John & Mary Story	F
Chunking	8	5	9	9	ToM Aggregate	6
Focus	~	~	13	14		
Prosody	5	9.5	7	11.5		
PEPS-C Total Score	Time 1	~	Time 2	123	* exaggerated prosody	





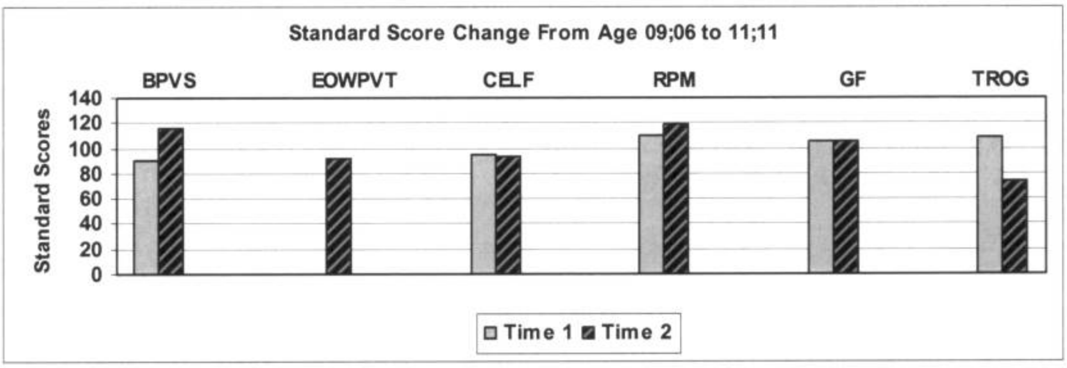


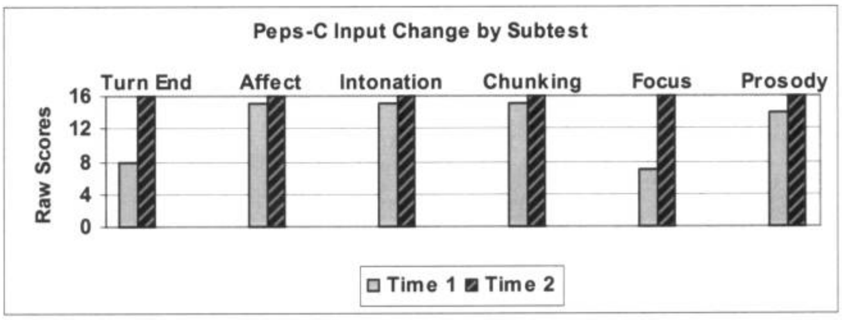
15H0906 - Male | Time 1 | Time 2 | Time Elapsed 2;04 yrs

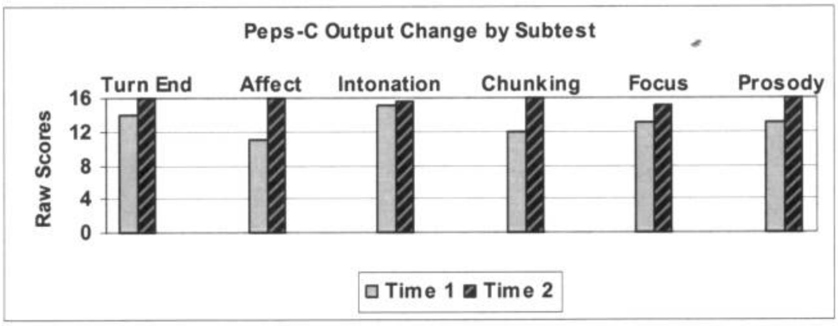
	Time 1	Time 2
Chronological Age	09;06	11;11

Language	Standard Score	
British Picture Vocabulary Scale (BPVS)	90	116
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	92
Clinical Evaluation of Language Fundamentals (CELF)	95	94
Raven's Progressive Matrices (RPM)	110	119
Goldman-Fristoe Test of Articulation (GF)	106	105
Test for Reception of Grammar (TROG)	109	74
Children's Communication Checklist (CCC & CCC-2)	(CCC 151)	35 General Communication Composite -18 Social Interaction Deviance Composite

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Typical Prosody		Typical Prosody			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	P
Turn end	8	14	16	16	Wellman Scale	5
Affect	15	11	16	16	Chocolate Story	P
Intonation	15	15	16	15.5	John & Mary Story	F
Chunking	15	12	16	16	ToM Aggregate	7
Focus	7	13	16	15		
Prosody	14	13	16	16		
PEPS-C Total Score	Time 1 152		Time 2 190.5			



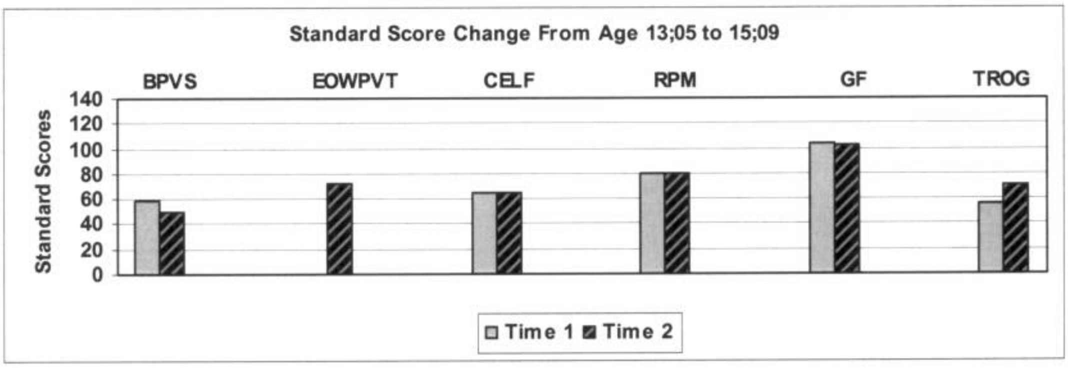


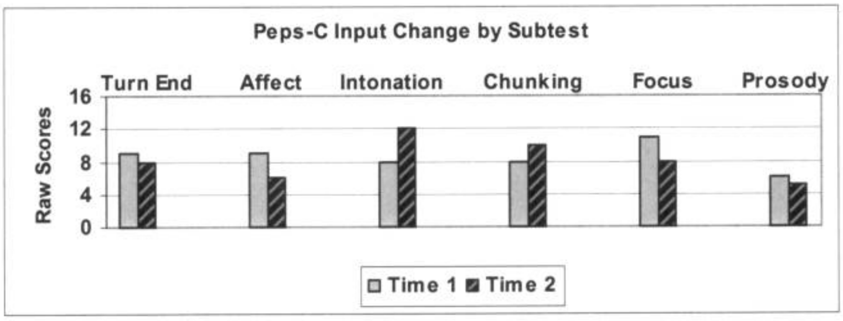


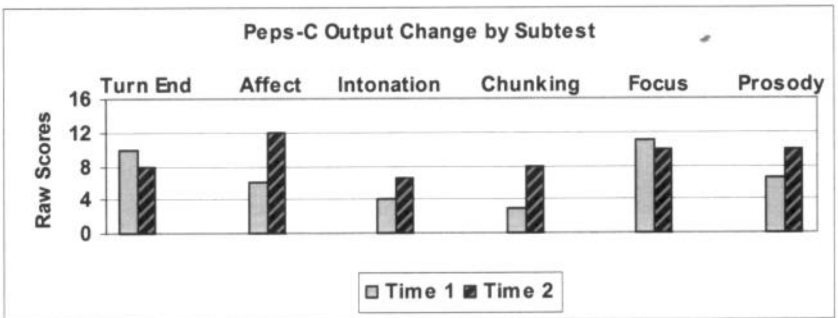
16H1305 - Male	Time 1	Time 2	Time Elapsed 2;04 yrs
Chronological Age	13;05	15;09	

Language	Standard Score	
British Picture Vocabulary Scale (BPVS)	58	50
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	73
Clinical Evaluation of Language Fundamentals (CELF)	64	65
Raven's Progressive Matrices (RPM)	80	80
Goldman-Fristoe Test of Articulation (GF)	104	103
Test for Reception of Grammar (TROG)	55	71
Children's Communication Checklist (CCC & CCC-2)	(CCC 125)	N/A General Communication Composite N/A Social Interaction Deviance Composite

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical Prosody		Atypical Prosody*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	P
Turn end	9	10	8	8	Wellman Scale	2
Affect	9	6	6	12	Chocolate Story	F
Intonation	8	4	12	6.5	John & Mary Story	F
Chunking	8	3	10	8	ToM Aggregate	3
Focus	11	11	8	10		
Prosody	6	6.5	5	10		
PEPS-C Total Score	Time 1	91.5	Time 2	103.5	*monotonous	





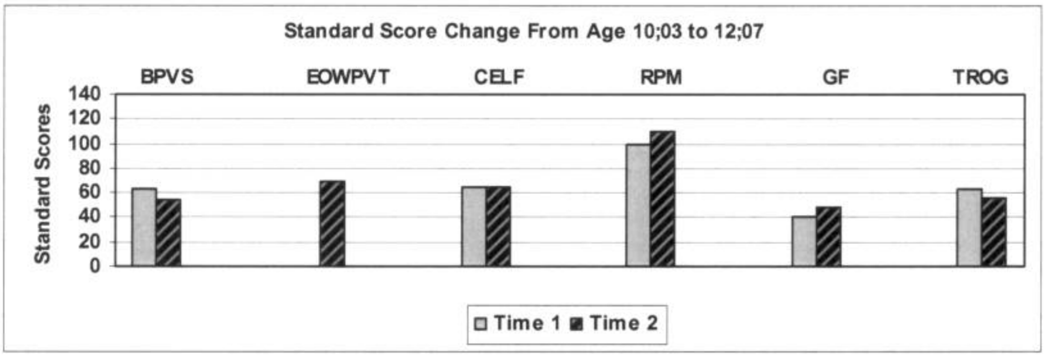


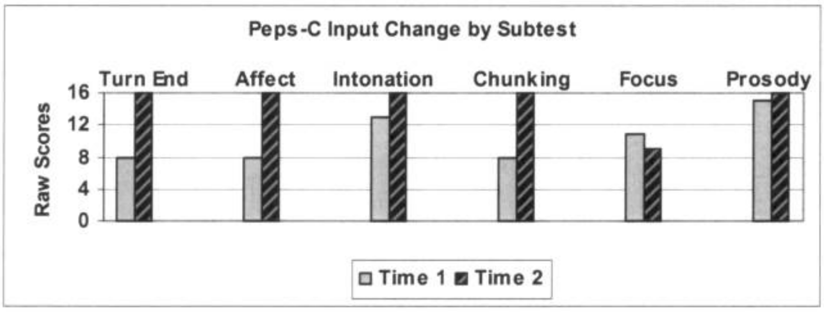
17H1003 - Male | | Time 1 | Time 2 | Time Elapsed 2;03 yrs

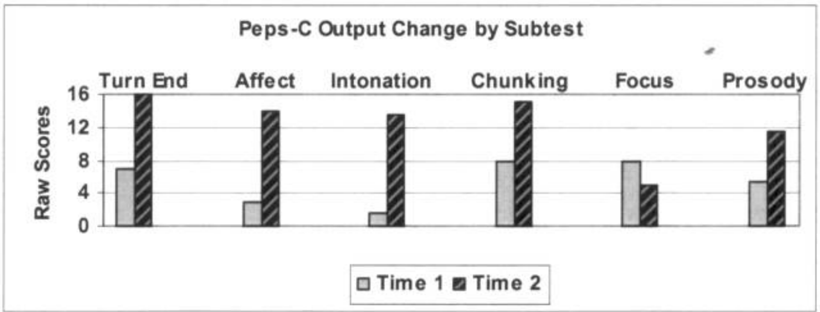
	Time 1	Time 2
Chronological Age	10;03	12;07

Language	Standard Score	
British Picture Vocabulary Scale (BPVS)	63	54
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	69
Clinical Evaluation of Language Fundamentals (CELF)	64	64
Raven's Progressive Matrices (RPM)	100	110
Goldman-Fristoe Test of Articulation (GF)	40	48
Test for Reception of Grammar (TROG)	63	55
Children's Communication Checklist (CCC & CCC-2)	(CCC 141)	23 General Communication Composite 2 Social Interaction Deviance Composite

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical Prosody		Atypical Prosody*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	F
Turn end	8	7	16	16	Wellman Scale	2
Affect	8	3	16	14	Chocolate Story	F
Intonation	13	1.5	16	13.5	John & Mary Story	F
Chunking	8	8	16	15	ToM Aggregate	2
Focus	11	8	9	5		
Prosody	15	5.5	16	11.5		
PEPS-C Total Score	Time 1	96	Time 2	164	*exaggerated	





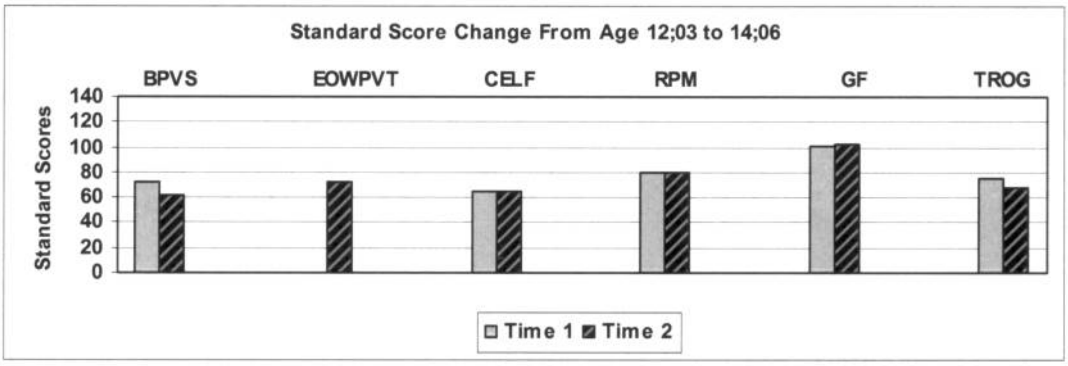


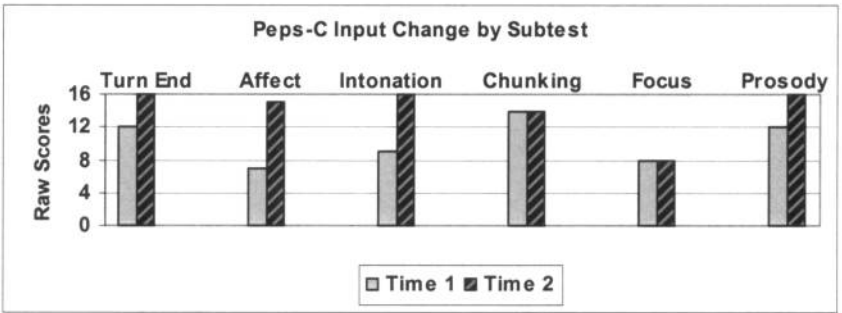
18H1203 - Male

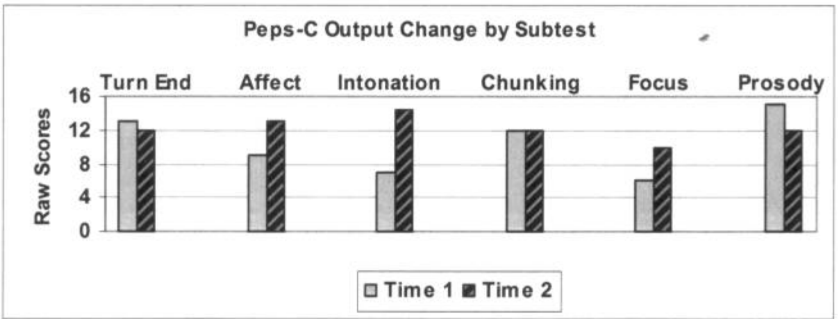
	Time 1	Time 2	Time Elapsed 2;02 yrs
Chronological Age	12;03	14;06	

Language	Standard Score		
British Picture Vocabulary Scale (BPVS)	72	62	
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	72	
Clinical Evaluation of Language Fundamentals (CELF)	64	64	
Raven's Progressive Matrices (RPM)	80	80	
Goldman-Fristoe Test of Articulation (GF)	101	103	
Test for Reception of Grammar (TROG)	76	67	
Children's Communication Checklist (CCC & CCC-2)	(CCC 116)	28 General Communication Composite -17 Social Interaction Deviance Composite	

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical Prosody		Atypical Prosody*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	P
Turn end	12	13	16	12	Wellman Scale	1
Affect	7	9	15	13	Chocolate Story	F
Intonation	9	7	16	14.5	John & Mary Story	F
Chunking	14	12	14	12	ToM Aggregate	2
Focus	8	6	8	10		
Prosody	12	15	16	12		
PEPS-C Total Score	Time 1 124		Time 2 158.5		*exaggerated	





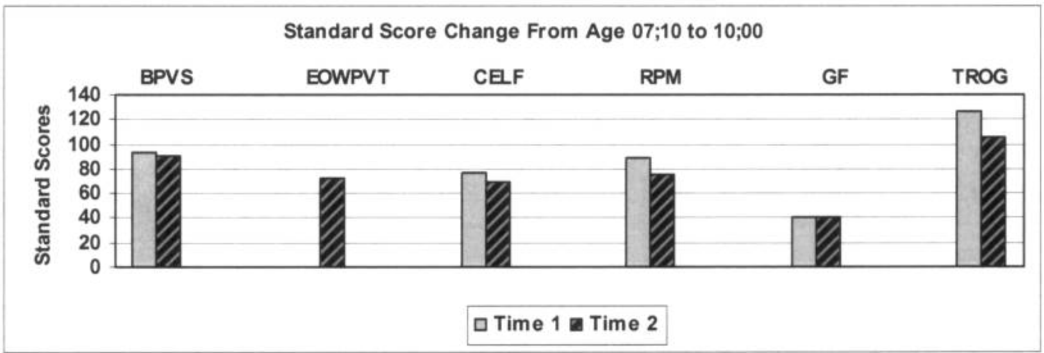


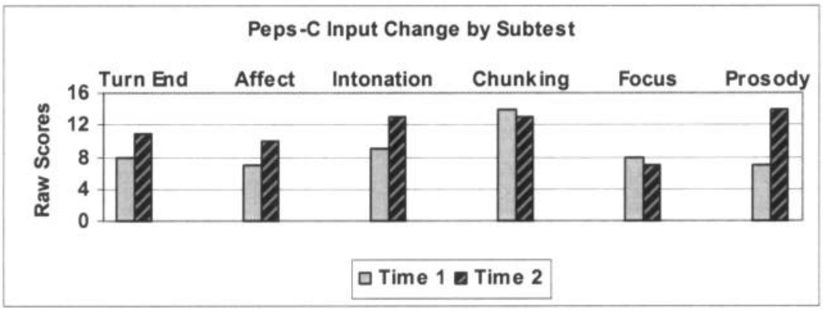
19H0710 - Female | **Time 1** | **Time 2** | **Time Elapsed 2;02 yrs**

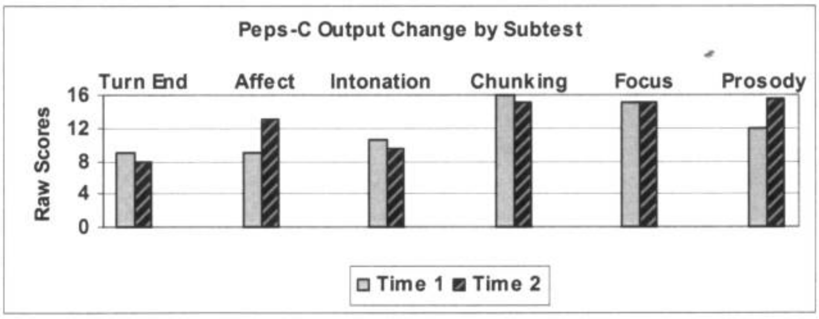
Chronological Age 07;10 | 10;00

Language	Standard Score Time 1	Standard Score Time 2
British Picture Vocabulary Scale (BPVS)	94	90
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	73
Clinical Evaluation of Language Fundamentals (CELF)	77	70
Raven's Progressive Matrices (RPM)	89	75
Goldman-Fristoe Test of Articulation (GF)	40	40
Test for Reception of Grammar (TROG)	126	106
Children's Communication Checklist (CCC & CCC-2)	(CCC 123)	40 General Communication Composite; -2 Social Interaction Deviance Composite

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Typical Prosody		Typical Prosody*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	P
Turn end	8	9	11	8	Wellman Scale	5
Affect	7	9	10	13	Chocolate Story	P
Intonation	9	10.5	13	9.5	John & Mary Story	F
Chunking	14	16	13	15	ToM Aggregate	7
Focus	8	15	7	15		
Prosody	7	12	14	15.5		
PEPS-C Total Score	Time 1	124.5	Time 2	144		







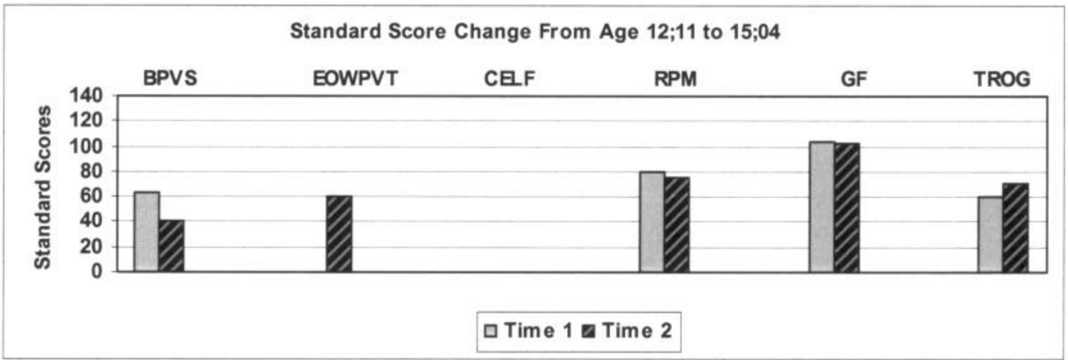
20H1211 - Male

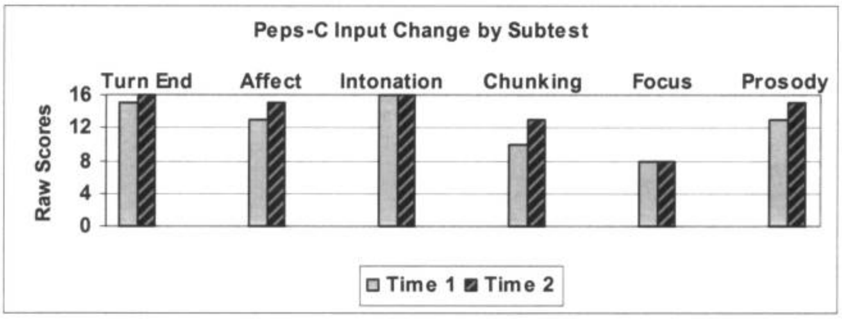
	Time 1	Time 2	Time Elapsed 2;05 yrs
Chronological Age	12;11	15;04	

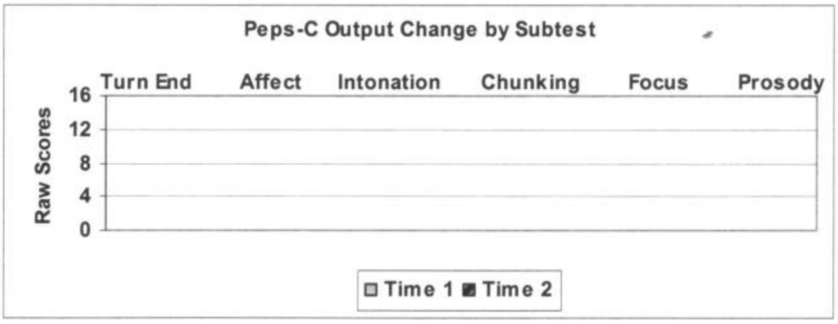
Language	Standard Score Time 1	Standard Score Time 2
British Picture Vocabulary Scale (BPVS)	63	40
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	60
Clinical Evaluation of Language Fundamentals (CELF)	~	~
Raven's Progressive Matrices (RPM)	80	75
Goldman-Fristoe Test of Articulation (GF)	104	103
Test for Reception of Grammar (TROG)	60	71
Children's Communication Checklist (CCC & CCC-2)	(CCC 115)	4 General Communication Composite 4 Social Interaction Deviance Composite

Prosody	Time 1		Time 2	
Subjective Judgment	No Judgment		No Judgment	
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT
Turn end	15	~	16	~
Affect	13	~	15	~
Intonation	16	~	16	~
Chunking	10	~	13	~
Focus	8	~	8	~
Prosody	13	~	15	~
PEPS-C Total Score	Time 1 ~		Time 2 ~	

Theory of Mind	
Smarties	F
Wellman Scale	1
Chocolate Story	F
John & Mary Story	F
ToM Aggregate	1







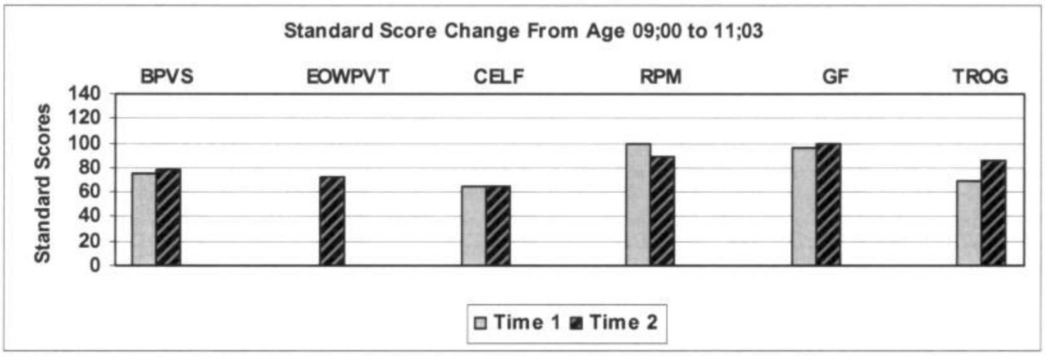
21H0900 - Male	Time 1	Time 2	Time Elapsed 2;02 yrs
Chronological Age	09;00	11;03	

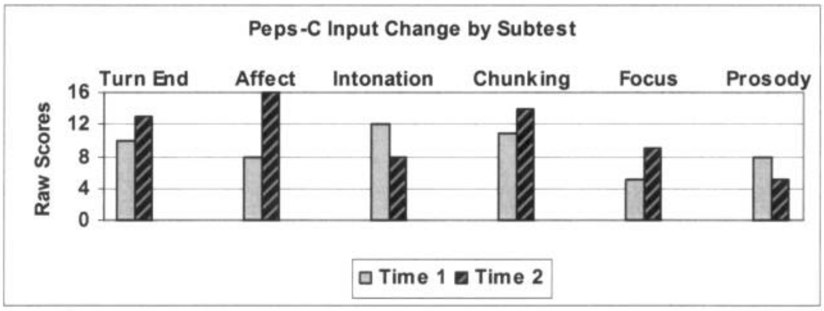
Language	Standard Score	
British Picture Vocabulary Scale (BPVS)	76	78
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	72
Clinical Evaluation of Language Fundamentals (CELF)	65	65
Raven's Progressive Matrices (RPM)	100	89
Goldman-Fristoe Test of Articulation (GF)	97	99
Test for Reception of Grammar (TROG)	70	86
Children's Communication Checklist (CCC & CCC-2)	(CCC 104)	13 General Communication Composite 3 Social Interaction Deviance Composite

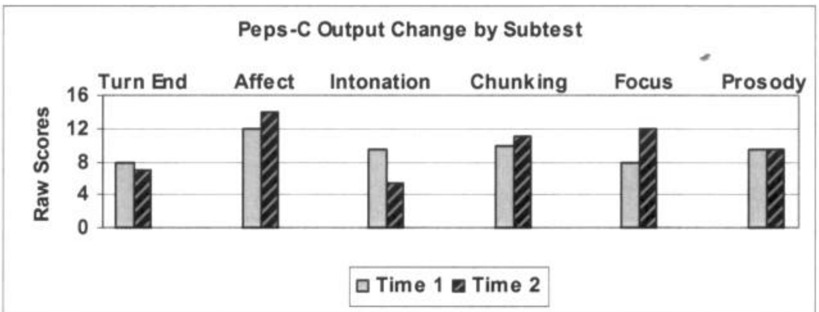
Prosody	Time 1		Time 2	
Subjective Judgment	Atypical		Atypical*	
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT
Turn end	10	8	13	7
Affect	8	12	16	14
Intonation	12	9.5	8	5.5
Chunking	11	10	14	11
Focus	5	8	9	12
Prosody	8	9.5	5	9.5
PEPS-C Total Score	Time 1	111	Time 2	124

Theory of Mind	
Smarties	F
Wellman Scale	2
Chocolate Story	F
John & Mary Story	F
ToM Aggregate	2

* exaggerated



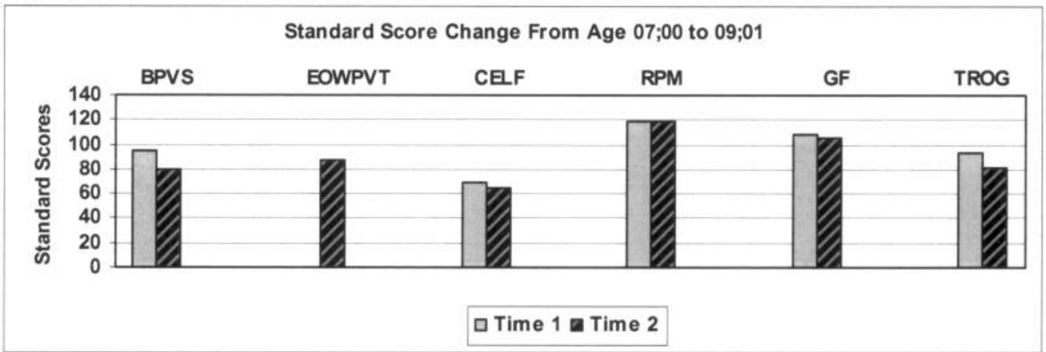


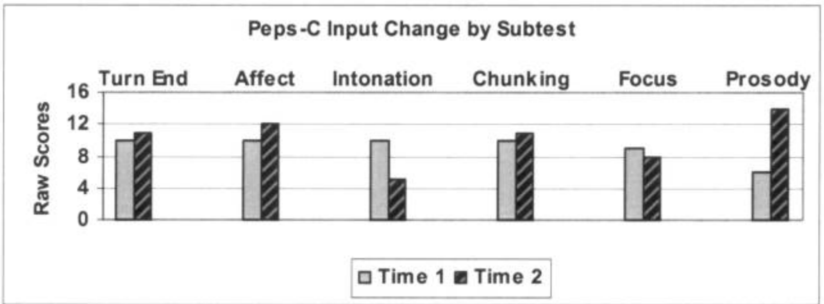


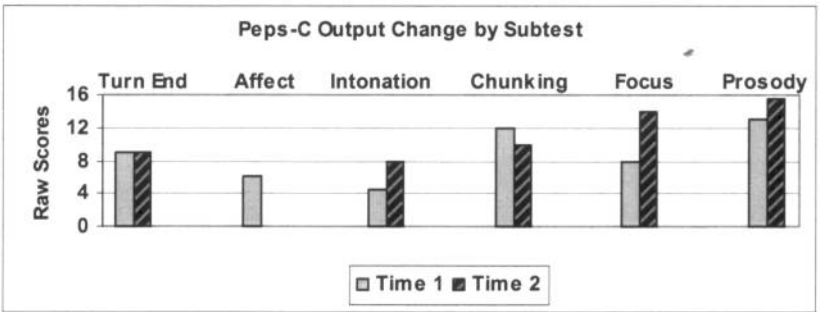
22H0700 - Male	Time 1	Time 2	Time Elapsed 2;00 yrs
Chronological Age	07;00	09;01	

Language	Standard Score		
British Picture Vocabulary Scale (BPVS)	95	80	
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	88	
Clinical Evaluation of Language Fundamentals (CELF)	69	65	
Raven's Progressive Matrices (RPM)	119	119	
Goldman-Fristoe Test of Articulation (GF)	109	106	
Test for Reception of Grammar (TROG)	94	81	
Children's Communication Checklist (CCC & CCC-2)	(CCC 99)	20 General Communication Composite -1 Social Interaction Deviance Composite	

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical		Atypical*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	F
Turn end	10	9	11	9	Wellman Scale	3
Affect	10	6	12	~	Chocolate Story	F
Intonation	10	4.5	5	8	John & Mary Story	F
Chunking	10	12	11	10	ToM Aggregate	3
Focus	9	8	8	14		
Prosody	6	13	14	15.5		
PEPS-C Total Score	Time 1	107.5	Time 2	~	* monotonous	



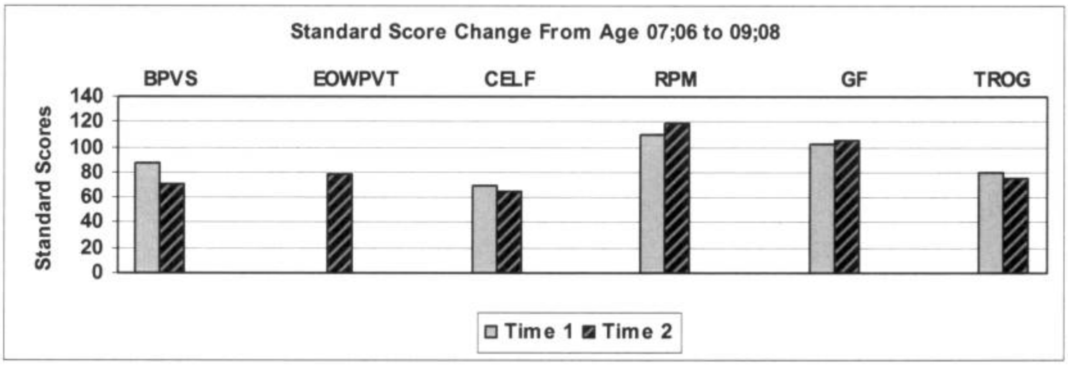


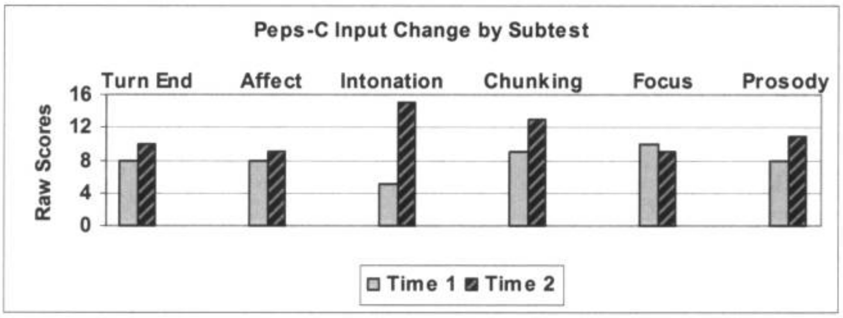


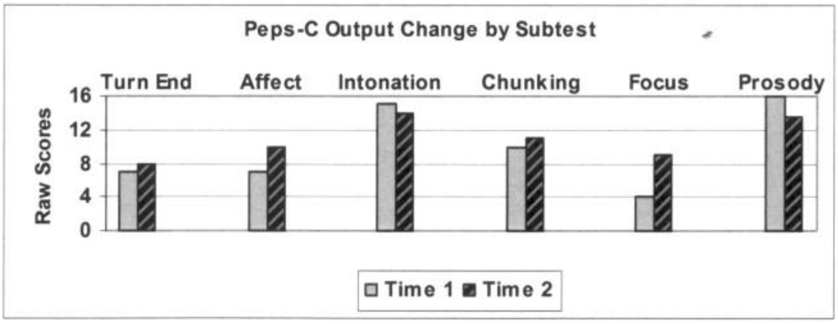
23H0706 - Male	Time 1	Time 2	Time Elapsed 2;01 yrs
Chronological Age	07;06	09;08	

Language	Standard Score		
British Picture Vocabulary Scale (BPVS)	87	71	
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	79	
Clinical Evaluation of Language Fundamentals (CELF)	69	65	
Raven's Progressive Matrices (RPM)	110	119	
Goldman-Fristoe Test of Articulation (GF)	103	106	
Test for Reception of Grammar (TROG)	80	76	
Children's Communication Checklist (CCC & CCC-2)	(CCC ~)	50 General Communication Composite -3 Social Interaction Deviance Composite	

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical		Atypical*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	F
Turn end	8	7	10	8	Wellman Scale	3
Affect	8	7	9	10	Chocolate Story	F
Intonation	5	15	15	14	John & Mary Story	F
Chunking	9	10	13	11	ToM Aggregate	3
Focus	10	4	9	9		
Prosody	8	16	11	13.5		
PEPS-C Total Score	Time 1 107		Time 2 132.5		* monotonous	





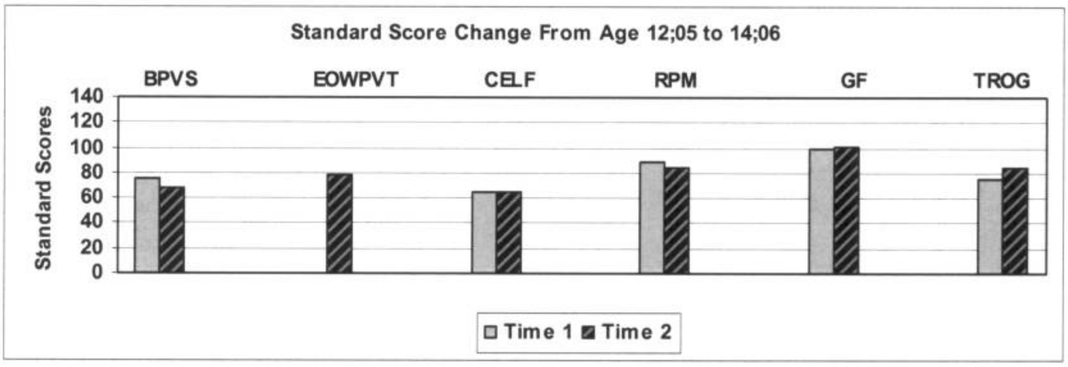


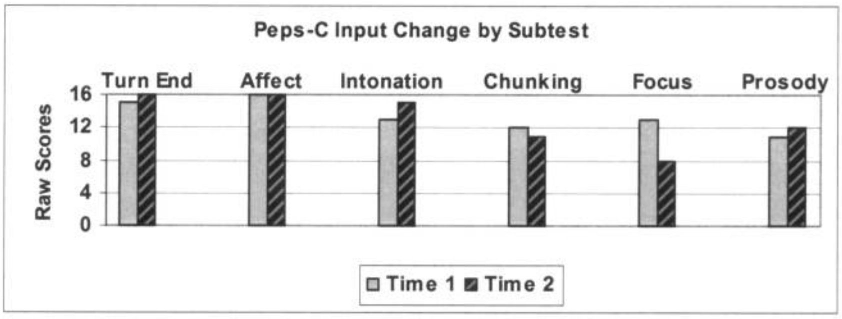
24H1205 - Female

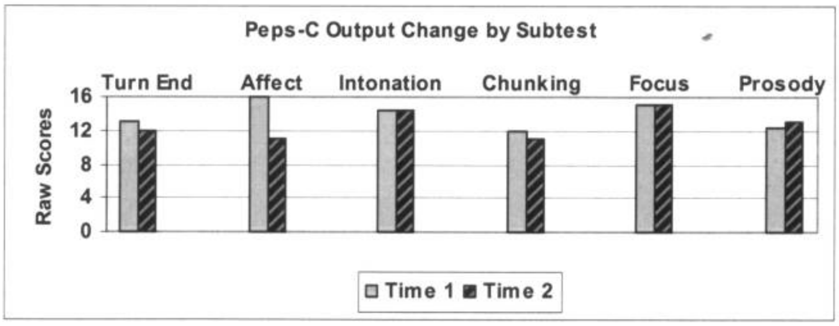
	Time 1	Time 2	Time Elapsed 2;01 yrs
Chronological Age	12;05	14;06	

Language	Standard Score	
British Picture Vocabulary Scale (BPVS)	76	68
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	79
Clinical Evaluation of Language Fundamentals (CELF)	64	64
Raven's Progressive Matrices (RPM)	89	84
Goldman-Fristoe Test of Articulation (GF)	99	101
Test for Reception of Grammar (TROG)	76	85
Children's Communication Checklist (CCC & CCC-2)	(CCC ~)	20 General Communication Composite -5 Social Interaction Deviance Composite

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical		Atypical*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	P
Turn end	15	13	16	12	Wellman Scale	4
Affect	16	16	16	11	Chocolate Story	F
Intonation	13	14.5	15	14.5	John & Mary Story	F
Chunking	12	12	11	11	ToM Aggregate	5
Focus	13	15	8	15		
Prosody	11	12.5	12	13		
PEPS-C Total Score	Time 1 163		Time 2 154.5		* monotonous	





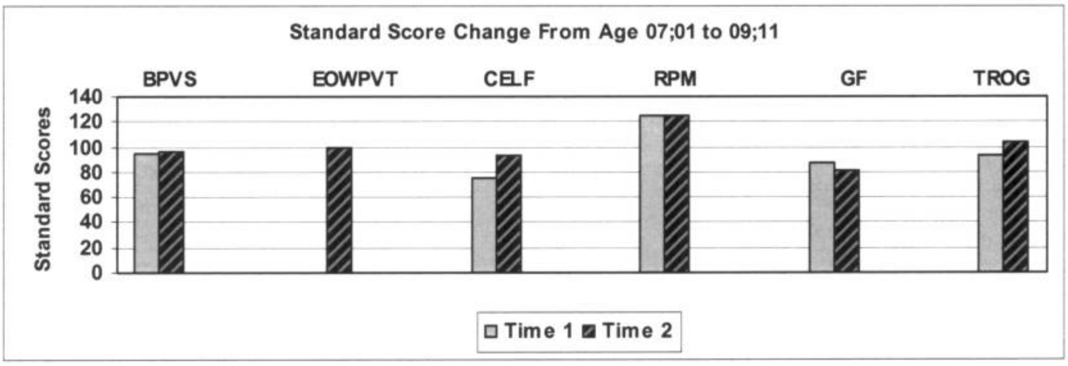


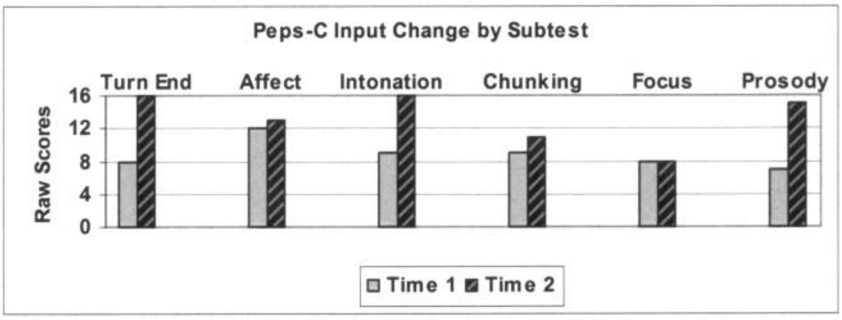
27H0701 - Male | Time 1 | Time 2 | Time Elapsed 1;10 yrs

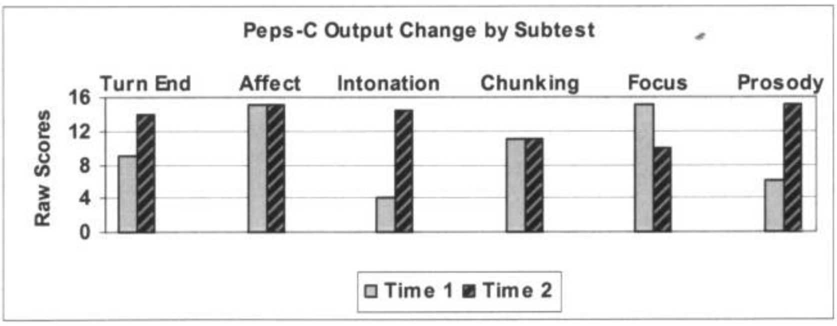
Chronological Age 07;01 09;11

Language	Standard Score	
British Picture Vocabulary Scale (BPVS)	95	97
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	99
Clinical Evaluation of Language Fundamentals (CELF)	75	94
Raven's Progressive Matrices (RPM)	125	125
Goldman-Fristoe Test of Articulation (GF)	88	81
Test for Reception of Grammar (TROG)	94	104
Children's Communication Checklist (CCC & CCC-2)	(CCC 126)	60 General Communication Composite -15 Social Interaction Deviance Composite

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Atypical		Atypical*			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	P
Turn end	8	9	16	14	Wellman Scale	5
Affect	12	15	13	15	Chocolate Story	F
Intonation	9	4	16	14.5	John & Mary Story	F
Chunking	9	11	11	11	ToM Aggregate	6
Focus	8	15	8	10		
Prosody	7	6	15	15		
PEPS-C Total Score	Time 1	113	Time 2	158.5	* monotonous	







30H0700 - Male | Time 1 | Time 2 | Time Elapsed 1;07 yrs

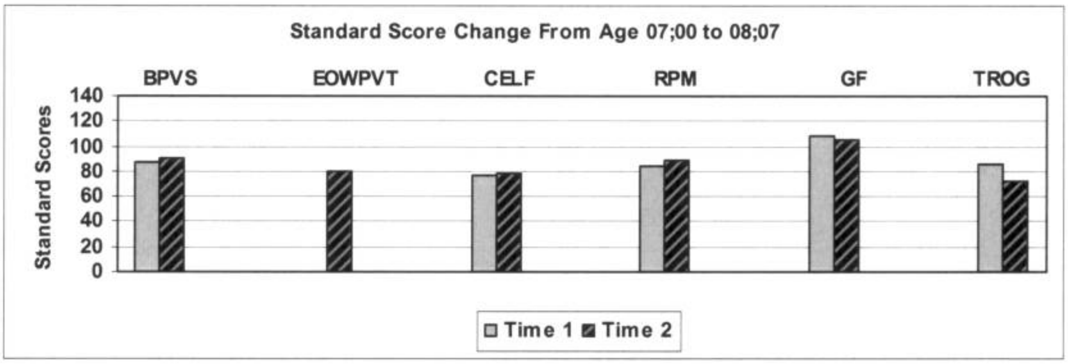
Chronological Age 07;00 08;07

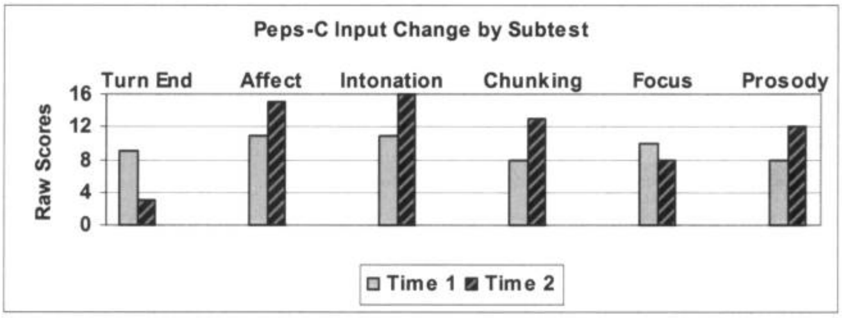
Language	Standard Score	
	Time 1	Time 2
British Picture Vocabulary Scale (BPVS)	87	90
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	80
Clinical Evaluation of Language Fundamentals (CELF)	77	78
Raven's Progressive Matrices (RPM)	85	89
Goldman-Fristoe Test of Articulation (GF)	109	106
Test for Reception of Grammar (TROG)	86	72
Children's Communication Checklist (CCC & CCC-2)	(CCC ~)	18 General Communication Composite -7 Social Interaction Deviance Composite

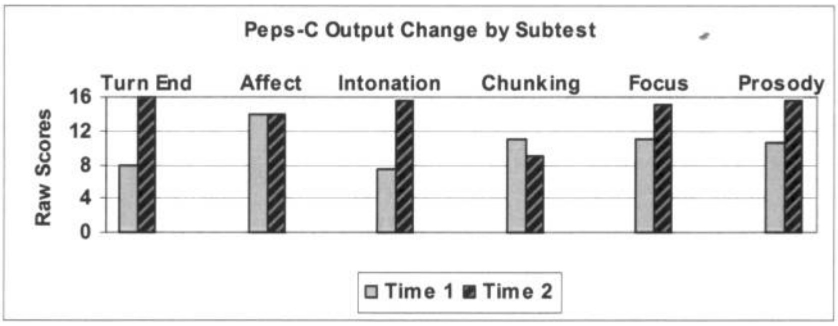
Prosody	Time 1		Time 2	
Subjective Judgment	Atypical		Atypical*	
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT
Turn end	9	8	3	16
Affect	11	14	15	14
Intonation	11	7.5	16	15.5
Chunking	8	11	13	9
Focus	10	11	8	15
Prosody	8	10.5	12	15.5
PEPS-C Total Score	Time 1 119		Time 2 152	

Theory of Mind	
Smarties	F
Wellman Scale	3
Chocolate Story	F
John & Mary Story	F
ToM Aggregate	3

* exaggerated







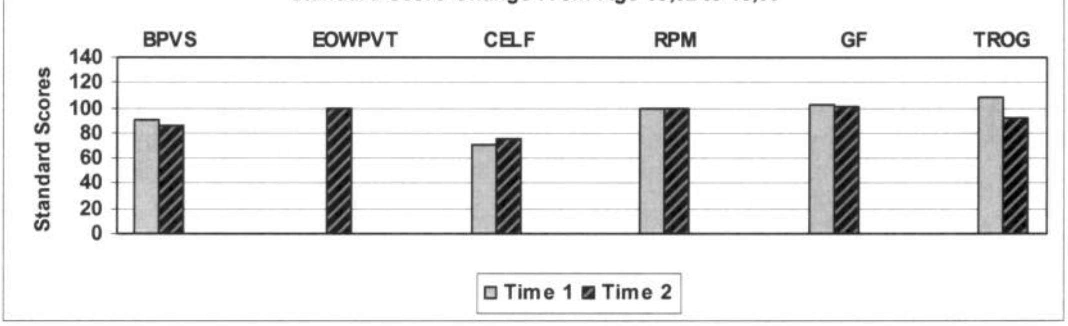
31H0902 - Female

	Time 1	Time 2	Time Elapsed 1;06 yrs
Chronological Age	09;02	10;09	

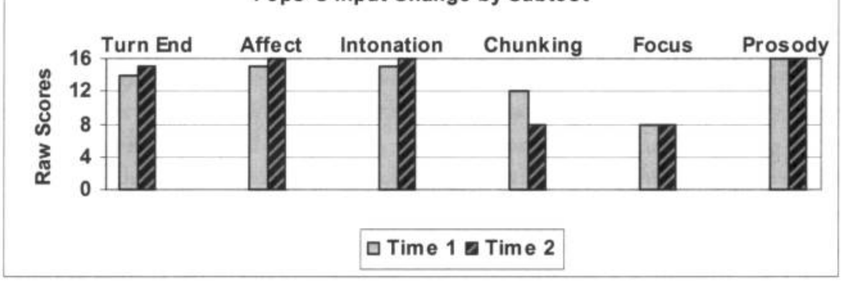
Language	Standard Score		
British Picture Vocabulary Scale (BPVS)	90	86	
Expressive One-Word Picture Vocabulary Test (EOWPVT)	~	99	
Clinical Evaluation of Language Fundamentals (CELF)	71	75	
Raven's Progressive Matrices (RPM)	100	100	
Goldman-Fristoe Test of Articulation (GF)	103	101	
Test for Reception of Grammar (TROG)	109	92	
Children's Communication Checklist (CCC & CCC-2)	(CCC 125)	23 General Communication Composite -14 Social Interaction Deviance Composite	

Prosody	Time 1		Time 2		Theory of Mind	
Subjective Judgment	Typical		Typical			
Peps-C Subtests	INPUT	OUTPUT	INPUT	OUTPUT	Smarties	F
Turn end	14	16	15	16	Wellman Scale	3
Affect	15	14	16	15	Chocolate Story	F
Intonation	15	12.5	16	15.5	John & Mary Story	F
Chunking	12	13	8	11	ToM Aggregate	3
Focus	8	16	8	11		
Prosody	16	15.5	16	16		
PEPS-C Total Score	Time 1 167		Time 2 163.5			

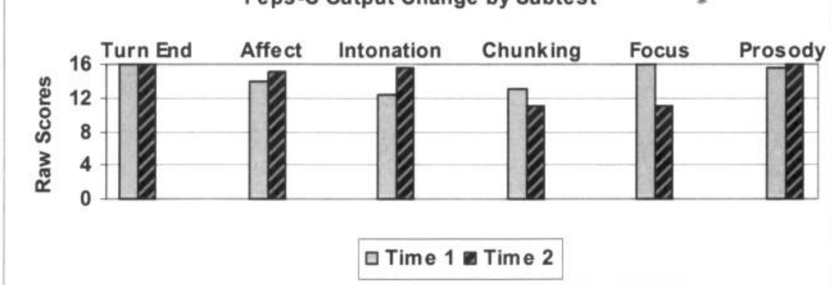
Standard Score Change From Age 09;02 to 10;09



Peps-C Input Change by Subtest



Peps-C Output Change by Subtest



APPENDIX XII

Language and Prosody in Children with High-Functioning Autism.

Test Descriptions

BPVS:

The **British Picture Vocabulary Scale** is a measure of vocabulary understanding. During the test, the child is asked to point to one of four black-and-white pictures to match increasingly difficult words spoken by the examiner.

EOWPVT:

The **Expressive One Word Picture Vocabulary Test** is a measure of expressive vocabulary. The child is asked to name coloured pictures of single words. This test was not given the first time your child was assessed, therefore only one score is listed.

CELF:

The **Clinical Evaluation of Language Fundamentals** (expressive subtests): Only the expressive portion of this test was given and is a measure of the child's ability to formulate and use language. First, the child is shown a picture and asked to make sentences using words named by the examiner. Next, the examiner says a sentence and the child is asked to repeat it back exactly. Third, the child is shown written words which are jumbled up and asked to make two different sentences with the words (the words are also read aloud to the child).

TROG -2:

The Test for Reception of Grammar is a measure of the child's understanding of grammatical structures. The examiner says a sentence and the child is asked to point to the one of four coloured pictures that best matches the sentence.

RPM:

The Raven's Progressive Matrices test is a measure of the child's non-verbal problem solving skills. Visual designs of increasing complexity are shown and the child is asked to choose one of six pictured bits of the design that would complete it.

GF:

Goldman Fristoe Test of Articulation measures your child's speech production within single words. The score reflects the number of speech errors, therefore, **the score should go down** over time. If your child did not have any speech errors the first time, the test was not given again.

(ToM):

Theory of Mind

ToM refers to the ability to understand how others may feel, perceive, or have beliefs separate from another individual. A variety of tasks were presented in story form on the computer and one story was told with toys. In the stories, one character has different knowledge than another character and the child has to predict what will happen based on their understanding of both characters differing perspectives. It requires an individual to take into account the perspective of another. These tests were not given at the first time of testing. The scale gave a possible score of 10.

PEPS-C.

Profiling Elements of Prosodic Systems- Children (Prosody assessment)
The test consists of twelve subtests plus a vocabulary check test.
Four areas are assessed – turn-end, affect, chunking and focus. For each of these areas both receptive (input) and expressive (output) abilities are considered.

Turn-end Type.

For the input task children are asked to listen to single words (food items) and decide whether they sound like questions, i.e. if the person on the computer was "asking them if they want some" or if they sound like statements, i.e. if the person was "just telling them what the food is". For the output task the child is required to produce this distinction.

Affect.

The distinction between liking and disliking a food-item is used. The child is asked to listen to a word and decide if it sounds as though that person likes or dislikes (or "feels happy or sad") that food. Again, the child is then required to produce this distinction.

Chunking.

In this task the children are asked to listen to phrases like "chocolate biscuits and jam". This can sound like two things (chocolate-biscuits and jam) or three (chocolate, biscuits and jam), the children are asked to decide which applies. Again, the children are then asked to produce similar phrases.

Focus.

Sometimes called "contrastive stress"; children are asked to identify which item the person on the computer forgot to buy from phrases such as "I wanted BLUE and black socks" with focus (stress) on "blue". The output task involves the same distinction but requires the child to listen to a football commentator and correct his utterances, for example, a blue sheep appears on the computer screen but the commentator says, "Now the red sheep's got the ball". The required response is "no, the BLUE sheep's got the ball".

Form Tasks.

A "form" task assesses whether a child has the underlying skills need to complete the above tasks. There are both input and output form tasks.

For input form tasks the children are asked to listen to pairs of sounds and decide if they sound the same or different. The sounds are "laryngograph signals" collected by placing a devise known as the laryngograph on a speaker's throat (over the voice box) while she is speaking. This results in a "hum" which sounds a bit like someone in an adjacent room talking. This task is designed to assess whether a child can hear the differences (whether they have the auditory discrimination skills) between sounds.

For the output form tasks the children are required to repeat words "exactly as they hear them from the computer". This task is a way of eliciting a child's ability to be able to produce the different types of intonation used in the test.

APPENDIX XIII

Queen Margaret University College

Lianne Carroll, M.S., Reg MRCSLT
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September 2005

Dear Mr & Mrs 23H,

Thank you to you and 23H for participating in the follow-up language study on prosody and language in children with high-functioning autism. Your time and effort are greatly appreciated.

Enclosed is a summary of the results from this most recent set of testing, with direct comparison to 23H's results from the original test date. There is also information about the content and purpose of each of the assessments.

Please feel free to phone if you have questions about any of the information. If so, phone Lianne at 317-3656 or send an email to the address above.

Thanks very much again. Best wishes to 23H and your family.

Sincerely,

Lianne Carroll, M.S. Cert MRCSLT
Speech Language Therapist
PhD Research Student

Funding for this study gratefully received from Sick Kids Friends Foundation, Edinburgh
http://www.edinburghsickkids.org/index.htm

APPENDIX XIV

Scores for 23H

Raw Scores	Testing Time 1 Age 7;06	Testing Time 2 Age 9;08	Comments
BPVS	55	60	Gains noted
EOWPVT	-**-	70	
CELF	17	33	Gains noted
RM	26	34	Gains noted
TROG -2	10	10	No gain
PEPS-C Total	107	132.5	Gains noted
Turn end in	8	10	Gains noted
Turn end out	7	8	Gains noted
Affect in	8	9	Gains noted
Affect out	7	10	Gains noted
Intonation in	5	15	Gains noted
Intonation Out	15	14	No gain
Chunking in	9	13	Gains noted
Chunking out	10	11	Gains noted
Focus In	10	9	No gain
Focus Out	4	9	Gains noted
Prosody in	8	11	Gains noted
Prosody Out	16	13.5	No gain
ToM	-**-	3/10 tasks passed	Skills emerging
GF	2 sound errors	0 sound errors	Improvement

NOTE: DETAILED DESCRIPTION OF ASSESSMENTS IS ATTACHED

-**- Test not administered at Time 1
-Δ- Test not given/incomplete results

It was a pleasure to meet and work with 23H. 23H completed all tasks presented over 3 sessions. He made gains in his receptive vocabulary skills, which were in-line with his expressive vocabulary skills. 23H also made gains on the expressive language test (CELF) and with the non-verbal assessment. He made nice gains on the overall score for the prosody assessment (PEPS-C). He demonstrated emerging theory of mind skills and his sound production skills improved at the single word level.

Signed______________________________ Date______________

Lianne Carroll, M.S., Cert MRCSLT
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APPENDIX XV

Abstract for American-Speech-Hearing Association Annual Convention, November 2005
San Diego, CA, USA

Language, prosody, and theory of mind in children with autism.

Lianne Carroll, Queen Margaret University College, Edinburgh U.K.

Abstract:

This study is investigating prosody and language skills over time in 31 children with high-functioning autism, aged 9 -16 years. The relationship between these measures and theory-of mind (ToM) skills will be examined. The children complete a computerized assessment of prosody, false belief and second order ToM tasks, and a battery of speech, language and non-verbal assessments. Data collection is ongoing. 10 of 11 children assessed thus far performed better on the prosody assessment at time 2 and prosody correlates highly with language. The ToM results show the expected absence or delay of skills, with a strong correlation to language.

Prosody and Language in Children with Autism.

Lianne Carroll[1], Joanne McCann[1], Sue Peppé[1], Fiona Gibbon[1], Anne O'Hare[2&3] and Marion Rutherford[2].
[1]Queen Margaret University College, Edinburgh. [2] Royal Hospital for Sick Children, Edinburgh [3] University of Edinburgh.

Visit out website:http:sls.qmuc.ac.uk/research/autism/index.htm

BACKGROUND

•As part of the communication impairment in autism individuals frequently have disordered prosody. This adds an additional communication and social barrier for these individuals, and problems are often life-long even when other areas of communication improve. However, few studies exist that quantify this disorder (McCann & Peppé, 2003).

•A new procedure for Speech and Language Therapists to assess prosodic ability in children (Profiling Elements of Prosodic Systems in Children – PEPS-C, Peppé & McCann, 2003) looks at four different communicative functions in which prosody plays a key role.

•Children with autism show a pre-school language delay, with pragmatic and social aspects of language almost universally impaired.

•Other language skills (syntax, articulation and semantics) are much more variable.

STUDY DESIGN

Research Questions

•Are there differences in prosodic ability between children with autism and typically-developing children after adjusting for language ability?

•Do children with autism have difficulties, or indeed strengths, in specific aspects of prosody?

•Is prosody in children with autism related to other language and/or nonverbal abilities?

•What is the nature & relationship of expressive & receptive language, articulation, pragmatics and non-verbal ability in children with autism?

Participants

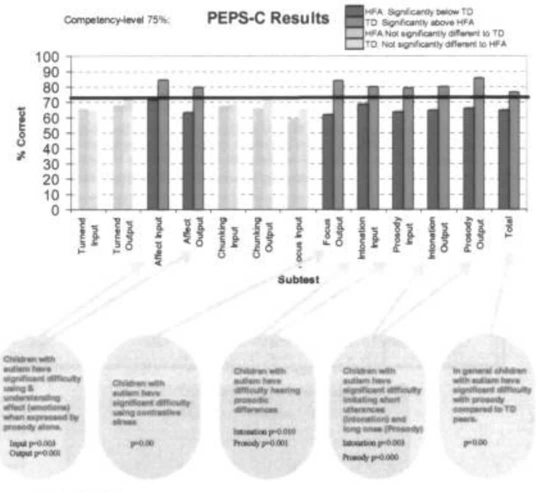
•31 children with high-functioning autism (HFA) aged 6 to 13 and 72 typically developing controls (TD) matched for verbal mental age, sex and postcode.

•All children had non-verbal ability within the normal range

•Receptive vocabulary >AE 5 years

Method

•All of the children completed the PEPS-C as a measure of receptive and expressive prosody. The children with autism completed a battery of speech, language and non-verbal assessments



PEPS-C Test Design.

•PEPS-C is based on a psycholinguistic framework (Stackhouse and Wells, 2001): it incorporates six input (reception) and six output (expression) tasks which are further divided into form tasks (bottom-up processing, where no meaning is involved) and function tasks (top-down processing, involving meaning).

•Four communicative functions are investigated: Turn-end type, Affect, Chunking and Focus. Each function is assessed in terms of both input and output skills.

Profiling Communication & Non-Verbal Ability

Receptive Language:
British Picture Vocabulary Scale-II (BPVS) for receptive vocabulary
Test for Reception of Grammar (TROG) for receptive grammar
Expressive Language:
Clinical Evaluation of Language Fundamentals U.K. , 3rd Ed (CELF) expressive subtests
Segments:
Goldman-Fristoe 2 Test of Articulation (GFTA)
Pragmatics:
Children's Communication Checklist (CCC)
Non-Verbal Ability
Raven's Progressive Matrices (RPM)

RESULTS:

•The HFA group performed significantly less well on the PEPS-C than the TD group (p=0.026, for total PEPS-C raw score).
•At subtest level, Affect Input, Intonation Output, Focus Output, Prosody Input and Prosody Output scores were all significantly lower (see Figure)
•For standardised measures the percentage of children performing within normal limits (SS≥85), with mild impairment (70≤ SS≤84) and with more significant impairment (SS≤69) was calculated.
•Paired t-tests were used to determine which aspects of language were most impaired.
•All of the children except one had a score out with the normal range on at least one of the language measures.
•All 3 language measures correlated highly (see figure below).
•The children had more difficulty with expressive language than receptive language
•Articulation was not a common area of difficulty, but skills were not necessarily spared.

Peps-C, language, non-verbal and age correlations

PEPS-C	BPVS	TROG	CELF	CCC	GFTA	RPM
Total	r=0.559,p=0.001	r=0.604,p=0.000	r=0.680,p=0.000	Not Sig	Not Sig	Not Sig
Input Total	r=0.779,p=0.000	r=0.585,p=0.001	r=0.717,p=0.000	Not Sig	Not Sig	r=0.502,p=0.005
Output Total	Not Sig	r=0.507,p=0.004	r=0.498,p=0.006	Not Sig	Not Sig	Not Sig

Looking ahead:

Longitudinal data is currently being gathered with this cohort of children, now aged 9 to 16. They are being assessed on all the same measures as noted above. In addition, theory of mind skills are being assessed with false belief and second-order tasks, as well as the 'theory of mind' scale (Wellman and Lui, 2004). The narratives for the theory of mind testing are recorded and the majority of the tasks are presented via the computer.

DISCUSSION:

•Unlike children with SLI, in autism prosody is related to language
•Pragmatics did not correlate with prosody. This may be due to the PEPS-C measuring abilities present in typical development whereas the CCC measures abnormal behaviours
•Articulation did not correlate with prosody suggesting that suprasegmental abilities are relatively discrete from segmental ones.
•The speech and language profiles support Kjelgaard & Tager-Flusberg (2001) who suggest that the language impairment in autism is similar to that of SLI.
•However, the finding that expressive language is more severally impaired warrants further research into the language impairment in specific subgroups of ASD
•We show a clear connection between language level and prosodic ability, but this was not found in Wells & Peppé's (2003) study of children with SLI.
•It is possible that the prosodic impairment may be cause by some other factor such as Theory of Mind
•Previous studies have already suggested that prosody can be viewed as a high-level ToM skill
•ToM correlates highly with language but previous studies have shown that children with autism have more difficulty with ToM than SLI ldren do
•The language skills of children with HFA are very heterogeneous, but most children show major difficulties. This is particularly severe for expressive language.

•If prosody can be viewed as a theory of mind skill rather than solely a language skill, this would explain why many high- functioning individuals with autism or Asperger's Syndrome and normal language continue to display disordered prosody.

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This research was funded by a grant from the Scottish Executive Chief Scientist Office (CZB/4/3/4). We thank the parents, speech and language therapists, teachers and children who have supported and participated in this research.

The follow-up study is funded by the Sick Kids Friends Foundation, Edinburgh

CHIEF SCIENTIST OFFICE

Prosodic Skill Development Over Time in Children with High-Functioning Autism.

Lianne Carroll, Queen Margaret University College, Edinburgh, U.K.
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BACKGROUND

•Difficulty with social communication is a core diagnostic feature of autism. One of the ways in which social communication competence is realised is through the understanding and use of prosody to serve grammatical, syntactic and affective functions.

•Odd or atypical expressive prosody (AEP) adds to social isolation and exclusion and when present, persists over time, even when other speech abilities improve (Kanner, 1971).

•Impairments in expressive prosody have been widely reported. However, little is known about the understanding of prosody (McCann & Peppé, 2003).

•There is no published research to date that has studied changes in receptive and expressive prosody skills over time.

Profiling Elements of Prosodic Systems –Children (PEPS-C) Test Description

•PEPS-C is based on a psycholinguistic framework (Stackhouse and Wells, 2001); incorporating six input (reception) and six output (expression) tasks which are further divided into form tasks (bottom-up processing, where no meaning is involved) and function tasks (top-down processing, involving meaning).

•Four communicative functions are investigated: Turn-end type, Affect, Chunking and Focus. Each function is assessed in terms of both input and output skills. The entire assessment is presented on a laptop computer.

Examples of two PEPS-C subtests: Turn-end type & Focus :

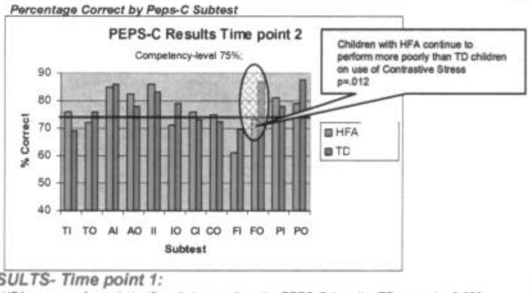
TURN-END TYPE

Turn-end type- Comprehending questioning versus declarative intonation on single words and then producing this distinction.

FOCUS

Focus- Using contrastive stress to clarify misinformation. For example, if the narrator says the white sheep has the ball, the child should clarify by saying 'the white COW.'

Percentage Correct by Peps-C Subtest



RESULTS- Time point 1:

•The HFA group performed significantly less well on the PEPS-C than the TD group (p=0.026, for total PEPS-C raw score).
•At subtest level, Affect Input, Intonation Output, Focus Output, Prosody Input and Prosody Output scores were all significantly lower (Peppé, McCann, Gibbon, O'Hare & Rutherford, 2006).

RESULTS- Time point 2:

•The HFA group made significant gains on total PEPS-C scores (Wilcoxon signed ranks p<.01), therefore the gap between HFA and TD children on total score seen at Time point 1 is no longer evident (Mann-Whitney U, z=-.634, p=.526)
•A significant difference in results on contrastive stress expressive subtest continues to exist (Mann-Whitney U, z=-2.527, p=.012).

DISCUSSION:

•Children with HFA are able to make significant gains in their understanding and use of prosody as assessed by the PEPS-C, indicating that most of the skills assessed reflect a delay, rather than deviance.
•Despite overall gains on the PEPS-C, no change was noted in the listener's judgment of the presence of AEP from Time Point 1. Therefore all 16 of the children identified with AEP at Time Point 1 continued to have 'odd', 'robotic' or 'exaggerated' prosody as a conspicuous characteristic of their verbal expression.
•More naturalistic assessment measures are required to quantify the presence of AEP and research is needed to investigate remediation of AEP.

•Results demonstrated that use of contrastive stress continues to be significantly below that of TD verbal-age matched peers indicating deviance. Difficulty with producing contrastive stress in children with autism has previously been reported (Shriberg et al, 2001; Paul et al, 2005). Shriberg et al (2001) note difficulties with contrastive stress in pragmatic tasks may reflect social cognition challenges faced by individuals with autism and HFA, such as those found with impaired theory of mind (Baron-Cohen, 1989).

•Intervention targeting improvement in use of contrastive stress in conjunction with improving understanding of theory of mind is therefore an important area to investigate.

STUDY DESIGN

Research Questions

•Will observed differences in prosodic ability between children with autism and typically-developing children continue over time?

•If gains or regression in skills are noted, in which prosodic skills will they occur?

•Will continuity or change in scores on PEPS-C be reflected in presence of atypical expressive prosody?

Method

•All of the children completed the PEPS-C and British Picture Vocabulary Scale (Dunn, Dunn, Whetton & Burley, 1998) at both Time Points.
•The children with HFA completed a further battery of speech, language and non-verbal cognitive assessments.
•At Time Point 2, the HFA group were also administered a theory of mind assessment battery.
•All assessments were administered by a certified speech and language therapist.

Participants

❖***At Time Point 1:*** 31 children with high-functioning autism (HFA) from a CSO funded study "Prosody and Language in Children with HFA" (McCann, Peppé, Gibbon, O'Hare & Rutherford, 2005).

•Diagnosed by multi-disciplinary team and consultant paediatrician based on ICD-10 criteria (World Health Organisation, 1992).

•HFA criteria: history of preschool language delay and non-verbal cognitive skills within normal range

• HFA group aged 6 to 13 years (mean 9.83) and 72 typically developing controls (TD) matched for verbal mental-age, sex and socio-economic status

❖***At Time Point 2:*** 24 of the original 31 children with HFA, now aged 8 to 16 years (mean 11.91)and 24 TD controls matched for verbal mental-age and sex.

•***Additionally (At Time Point 2)***, 16 of the 24 children with HFA were judged to have atypical expressive prosody (AEP) and characterized as robotic (1), sing-song (1), exaggerated (7), flat (4)or odd (3).

PEPS-C Scoring.

•Input (receptive) tasks all provide a binary choice for responses; pass criterion is 75% or greater (12 or more correct out of 16).

•Output (expressive) tasks require examiner to make a perceptual judgment of child's use of prosody; judgment is entered on a specially marked keypad. Therefore, inter-rater and inter-rater agreements were calculated on 25% of data (see tables below).

Peps-C Inter- and Intra-Rater Agreement by Items

	TurnEnd	Intonation	Affect	Chunking	Prosody	Focus	Mean
Inter-Rater	97.9	82.1	69.80	87.37	81.25	86.46	84.15
Intra-Rater	97.92	86.32	88.54	94.73	85.42	90.6	90.63

Peps-C Inter- and Intra-Rater Agreement by Score

	TurnEnd	Intonation	Affect	Chunking	Prosody	Focus	Mean
Inter-Rater	98.7	96.4	84.1	92.8	94.7	97.2	93.98
Intra-Rater	98.7	94.7	100	95.7	94.1	95.8	96.5

Further Work:

This poster presents a portion of data from the author's ongoing PhD research project entitled 'Language Development and its Relationship to Theory of Mind in Children with High-Functioning Autism.'

Acknowledgements:

Many thanks to the children, families, therapists and teachers who participated in this research.

Additional thanks to The Centre for Integrated Healthcare Research for assistance with statistical analyses

Funding for this research provided by Sick Kids Friends Foundation, Edinburgh, Scotland, U.K.

Centre for Integrated Healthcare Research

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APPENDIX XVIII

Theory of Mind Development in Children with High-Functioning Autism

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1 Introduction

High-functioning autism (HFA) refers to a subgroup of children with autism spectrum disorders who have non-verbal cognitive skills within the average range but have a history of language and communication impairments. Children with HFA have well-documented delays in the development of theory of mind (ToM) skills, particularly on false-belief and 2nd order tasks. However, much less is known about development of a earlier range of ToM skills and whether or not they follow the same progression as those with typical development.

Previous research has shown that typically developing (TD) American preschool children follow a consistent developmental progression on five ToM tasks that form a developmental scale, as confirmed by Rasch analysis. (Wellman & Liu, 2004). A related research study on TD Australian children confirmed they follow the same developmental progression on the scale as the American TD children (Peterson et al., 2005). However, TD Chinese children follow a different developmental course (Wellman, Liu, Fang, Zhu & Liu, in press) suggesting an influence of culture on the order in which these skills develop.

Peterson et al. (2005) found that Australian children with HFA passed tasks on the Wellman & Liu scale in a different order than the American and Australian TD children (but not the same pattern as the Chinese children) suggesting a different developmental course in HFA.

2 Aims

- To adapt the Wellman and Liu scale into an assessment that can be presented on a laptop computer using recorded narratives to control for the language and prosody input.

- To investigate whether Scottish children with HFA will:
  - ➢ follow the same developmental pattern of ToM skills as did the TD American and Australian children,
  - ➢ follow the same or similar pattern as the Australian children with HFA
  - ➢ present a different developmental progression altogether, possibly due to cultural differences.

- To assess second-order ToM skills for comparison to results on the Wellman Scale

- To investigate the relationship of ToM skills with measures of language ability.

Acknowledgements:

- Sick Kids Friends Foundation, Edinburgh for generously funding this research
- Robert Rush and The Centre for Integrated Healthcare Research for assistance with statistical analyses
- Prof Fiona Gibbon, Dr Janet Beck, Dr Anne O'Hare for PhD supervision of this work

Presented 22 September 2006 ~ University of Edinburgh

3 Investigation

Participants

24 Scottish children with HFA aged 9 – 16 years (M 11;11) diagnosed by a multi-disciplinary team based on ICD-10 criteria

Assessments Administered

- Five ToM tasks that make up the Wellman Scale
- Additional 1st and 2nd order ToM tasks
- Receptive and expressive vocabulary skills, receptive grammar skills and expressive language skills

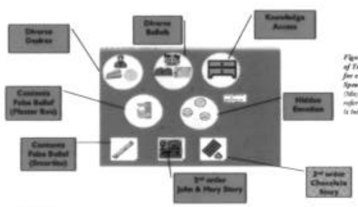

Figure 1. The main menu of ToM tasks as designed for computer using Speaking Dynamically Pro (Mayer-Johnson, Inc). For reference, each of the tasks is individually labelled

ToM Tasks:

- Wellman & Liu Scale is comprised the following tasks (ordered from easiest to most difficult) which assess:

  Diverse Desires: understanding that although the child prefers one snack, another person can desire a different snack

  Diverse Beliefs: understanding that although the child thinks a cat is hiding in one location, another person may believe it is in a different location

  Knowledge Access: understanding that a person cannot accurately know what is in a particular location (such as a closed drawer) without being able to see the contents inside

  Contents False Belief: understanding that if a person has not seen inside a familiar container such as a plaster box, he will not be able to know that it contains an unexpected item

  Hidden Emotion: understanding that a person can feel one emotion while trying to display a different emotion (e.g., feeling sad but trying to look happy)

- Contents false-belief (same principle as in the Wellman scale, but using a Smarties container)
- 2nd order tasks (require the child to predict what one person thinks another person will think; were assessed with 2 separate stories with differing linguistic complexity)

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4 Results

Table 1. Scores for all ToM tasks for each participant. Results are ordered by verbal mental age as determined by receptive vocabulary age-equivalent scores on the British Picture Vocabulary Scale (BPVS).

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Total	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 2. Comparison of findings with previous studies with details of percentage of group that passed each task on the Wellman ToM scale. Percentages values for Chinese TD children were not available, therefore the order in which the tasks were passed are presented. Highlighted areas indicate differences in order of tasks passed.

	Diverse Desires	Diverse Beliefs	Knowledge Access	Contents False Belief	Hidden Emotion
American TD (Wellman et al., 2004) [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Australian TD (Peterson et al., 2005) [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Australian HFA (Peterson et al., 2005) [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Scottish HFA (L.Carroll) [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Chinese TD (Wellman et al. In press) [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

- Scottish children with HFA passed the tasks on the Wellman ToM scale in the same order as the TD American and Australian children, providing evidence that they are following the developmental progression of skills found thus far in Western culture.
- This pattern of development is confirmed by a Rasch analysis which followed the same parameters specified in Wellman & Liu (2004) and Wellman et al. (in press).
- ToM scores correlated highly with language measures, but not with chronological age.
- Only 12.5% of the children passed a 2nd order ToM task (chocolate story) and 0% passed the more linguistically complex 2nd order task (John & Mary).

Table 3. Correlations between ToM and measures of language. (Spearman's rho)

	Wellman Scale
Chronological Age	ns
British Picture Vocabulary Scale (Receptive Vocabulary)	[illegible]
Expressive One-Word Vocabulary Test (Expressive Vocabulary)	[illegible]
Clinical Evaluation of Language Fundamentals - 3UK (Expressive Language)	[illegible]
Test for Reception of Grammar -2 (Receptive Grammar)	[illegible]

5 Summary

- Wellman & Liu ToM scale can be presented adequately via computer, allowing for use of recorded narratives ensuring consistency of verbal and prosodic input across participants.
- Scottish HFA children follow the same developmental path for early ToM skills as Western TD children but at a much older age (7 yrs later); contrasting with the Peterson et al. finding that HFA followed a different progression (possibly due to a change in wording by Peterson et al.).
- Children who passed 2nd order ToM tasks also passed all tasks on the Wellman Scale, suggesting the scale could be extended to include higher order skills.

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